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Science Education

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Volume 18 APRIL, 1934 Number 2

RESEARCH AND ELEMENTARY SCIENCE TEACHING*

OTIS W. CALDWELL

Institute of School Experimentation, Teachers College Columbia University

I shall speak briefly of four aspects of this topic: the acceptance of experimental research as an essential way of learning more about what and how to teach; the influence now exerted by specific investigations; coöperative investigations between research institutions and public schools; and some types of investigations still needed.

I. *Experimentation in schools* is now commonly accepted as one dependable method of finding what and how to teach. One recent course in elementary science opens its second paragraph with the statement that: "The course as here outlined is the result of ten years of experimentation with fourth-grade classes in the University Elementary School. It does not represent the end of the experimentation, merely the stage now reached in this experimentation."[1] It will be noted that this statement not only indicates the experimental basis for the course presented, but gives equal importance to the fact that it represents the present stage of experimentation that is still in progress.

*A paper read before the National Council of Supervisors of Elementary Science, Cleveland, Ohio, February 24, 1934.

Craig's important research, resulting in valuable instructional organization, is similarly and properly tentative in its nature.

An examination of other recommended work in elementary science indicates rather wide acceptance of experimentation as one of the necessary foundations. This is not merely a good selling device, though it is not discreditable when sound foundations prove to be marketable. More importantly it means that we are in a stage of curricular development in which we expect proved reasons for what we ask teachers to do. The generally recognized fact that we do not yet possess enough proved reasons for a full course of study need not be particularly discouraging. It is important, however, that we shall sense and use the reasons for actions that have been made clear; that we see the trend of these synthesized reasons; and that we continue to seek further evidence through further careful experimentation. There has been no time in my forty years of varied teaching experience when science teachers cared so much about research as a foundation for guidance in finding what science to

teach and how to teach it. It seems safe to say that there was never a time when so many fairly well trained science teachers were engaged in experiments of one kind and another designed to improve science teaching. Most of these experimenters are regularly engaged teachers who endeavor to effect improvements while doing regular school work. That is, the experimental attitude has become much more common as a part of regular school work.

II. *The influence that specific investigations now exert* or should be allowed to exert needs more careful citation. Miss Florence Weller, of Baltimore, and the six other members of her committee[2] recently published their study of elementary science in ten representative states. They show definite statistical evidence of increase in quantity and quality of work now being done, and in the scholarship of those teaching it. This study should stop one common false statement which alleges the decline of elementary science. Also teachers are improving in science scholarship, the evidence shows the direction in which the teachers are moving, even though they may not have gone as far as may have been desired.

Another recent study[3] has developed the coherent tendencies in point of view and objectives from the time of Agassiz to the present. This study shows that important parts of our methods and objectives now acclaimed are by no means new. Rather they have developed the experience of more than half a century, thus have the substantial support of tested experience by several leaders. Such long-time development adds to the importance of the results. We sometimes imagine that ideas are new to the world just because they are new to us. Such research as that cited should increase the stability of elementary science teaching by showing its prolonged and thoughtful development through the contributions of Agassiz, Crocker, Straight, Bailey, Jackman, the Comstocks, and others.

Another type of research now affecting elementary science instruction deals with attitudes. The evidence resulting from investigations indicates that desirable attitudes must be sought specifically. If we want pupils to possess certain science knowledge we teach for that specific knowledge. If we desire them to learn social coöperation, we have them engage in social coöperation. We now think that desirable attitudes are developed by doing the things which involve those attitudes. We used to talk about a scientific way of looking at problems. We often made very unscientific assertions about science studies as agents in developing desired attitudes. It now seems fairly well established that people's responses in life situations are guided in very important ways by the specific attitudes they have previously acquired. It therefore becomes of prime importance that education shall redirect itself toward development of desired attitudes, if only we may become more clear as to what attitudes are of greatest significance. Elementary science is peculiarly adapted to such teaching since its materials and problems are with us all the time, hence constantly available for practice in attitudes toward which educational effort should be directed.

III. *Coöperative investigations between Institutes of Research, Museums, Gardens, and the Schools* have recently added much to elementary science teaching. The Brooklyn Botanic Gardens and the Boyce Thompson Institute of Plant Research may be used as types. Such institutions were formerly visited as pastime by the curious. They now coöperate in experimental work of many kinds. For example, the rooms in which new plants are started from buds, stems, roots, stolons, leaves, *etcetera*, present good material for students of all ages. But younger pupils may also secure material and guidance for their production of new plants. Last summer, almost the entire research staff of the Boyce Thompson Institute devoted part of their time to coöperation with citizens of Yonkers, New York, in developing community and home gardens. The latest research was made available to all. The result was seen in thousands of

productive and beautiful gardens but even more in an amazing contribution to adult education.

IV. *There are, however, more investigations still needed* than have been made. May I cite the types by specific illustration? Many of the good experiments upon which courses of study have been based are not accompanied by real accurate measures of results. The experiments have doubtless been good, but being unmeasured, other teachers do not have adequate assurance of their correctness. Mere experiment in the sense of doing something in a different may may lead nowhere. No virtue exists in merely being different from the usual. A planned difference with control groups, measured for proof of what occurs, are essentials of a valid educational experiment. We have had few such experiments as yet. Hence our stated results and consequent recommendations are usually the opinions of experienced teachers. They are useful as opinions but often are not genuine proofs in a scientific sense. Then, the question of what to teach is inadequately answered, though Craig and others have made splendid contributions to it. If we accept each person's criteria for selection, we probably would accept the selection that follows. But the determination of criteria for selection has too often been made with less real evidence than is desirable.

Grade placement of the topics selected has been rather opportunistic in most cases. Learning studies by means of which to place or to reject selected science topics will doubtless yield rich results in the next decade. We surely need these investigations.

Possibly I should add a closing paragraph about what constitutes a valid investigation or experiment in elementary science. One must first clearly define the piece of work in which he is to engage. Since there probably are no wholly detached units of work, he must recognize and record the relations of his unit of work to those others that are organically connected with it. Only by so doing can he avoid confusion when his procedure later encounters these interrelations. Then with his proposed procedure clearly outlined, he will need to secure his experimental and control groups. These are measured so that what occurs during and as a result of his experiment may be set against what exists at the beginning of the experiment. With his experimental group the worker uses the element that is being tried. With the control group all is the same except the experimental element. Therefore any differences may be related to the experimental element. The final measurement compared with the initial measurement thus enables the worker to find what, if any difference, was caused by the experimental factor. These procedures need to be so carefully conducted that any subsequent worker doing the same experiment would reach the same results. Such standards of work are impersonal and objective and will persist through the changing individual interests of different research workers. Judged by these standards, we have a long way yet to go before research will make its best contributions to elementary science teaching. Recent research has made distinctive gains toward more careful use of these essentials in the further growth of knowledge about science teaching.

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THE JUNIOR SCIENCE CLUBS: AN AMERICAN INSTITUTE PROJECT IN SCIENCE EDUCATION*

MORRIS MEISTER

New York City Public Schools

At the stroke of the bell, announcing the beginning of the third teaching period of the day, the science teacher calls his class to order. Two other classes have come and gone; two others will come after the third period is over. In each group there are about forty eager adolescent minds. Before work can begin attendance must be checked and assignments attended to. If the teacher is so fortunate as to have had the previous class period free, he must now make certain that the English or History class which used the room last did not disturb or break the demonstration materials which he had prepared.

"Thirty-three minutes left," thinks the teacher to himself, "in which to put over the lesson on electrolysis." He is about to launch the subject when two hands are raised.

"What is it John?"

"Mr. Brown, I have here a newspaper clipping about a new discovery which reminds me of what you showed us yesterday; but I don't understand it."

"All right John," replies the teacher, "Post it on the Bulletin. Later we shall look into it. Now, we must go on."

The owner of the second raised hand also has a clipping—from a magazine—but noticing the teacher's anxiety to "move along," he decides to let the matter drop. He can embalm his clipping on the Bulletin Board without further instructions.

The work begins with a very interesting demonstration on electrolysis. It is so interesting, in fact, that all sorts of questions arise. Some of these the teacher answers; others are shunted aside. When Robert remarks that he has read about a kind of heavy water which is prepared by electrolysis, Mr. Brown replies that he "is afraid there isn't time to go into that now." If one could read the minds of the class, such thoughts as these would undoubtedly be found there:

— I wish I could try that experiment myself sometime.
— I think I'm going to try to explode some hydrogen when I get home this afternoon.
— I wonder if I can do this without platinum.
— Would table salt do as well as acid?
— He didn't really prove that there was exactly twice as much hydrogen as oxygen.
— Some day I'm going to be a chemist.

And, of course, there is a pupil here and there who has already done the experiment and who therefore adopts an attitude of annoyed superiority. There is also the pupil to whom the whole subject is a little bewildering, because he has not had a first-hand experience.

But the teacher can not stop too long or too often; since thirty-three minutes fly by too rapidly. The course of study must be covered; examinations must be passed; supervisors must be satisfied. In fact, the better the teaching, the greater is the temptation to follow paths of inquiry that will delay the completion of topics.

In contrast with the situation described above, let us consider the spirit which dominates a period of extra-curricular work.

No official bell is needed to mark the beginning and end of the club session. If attendance is taken, it is a requirement self-imposed by the members. Usually, the meeting room is well adapted for the purpose and its use can be restricted to work in science.

* Paper read before The Teachers of Science Conference arranged by the A. A. A. S. Committee on The Place of Science in Education at Cambridge, Massachusetts, December 29, 1933.

Assignments, if any, are individual and made on the basis of special interest or ability. A Club Scrap Book provides an outlet for clippings and a definite time is set aside for free discussion of current events in science. Since the size of the club is limited to the ability of the sponsor to guide properly individual interests, a varied, flexible program is made possible. The future chemists, engineers, and doctors can explore the outskirts of their future vocations, and the hobbyists can lay foundations for the joyful use of future leisure. Perhaps as important as any other value of the club is the fact that an atmosphere is created in which pupil learning, even in the traditional classroom sense, is made more possible and more effective.

In drawing the contrast so sharply between class and club, we recognize that classwork need not always be routinized and that many club activities fail to achieve good results. However, the essential distinction between the two, in the matter of appeal to individualized interests and the stimulus to creativeness, must be granted. In the last two or three decades, educators have accepted this distinction between curriculum and extra-curriculum and have encouraged the latter in many ways. We have seen theories and procedures developed which aim to bring the club spirit into the classroom and, in other ways, to break down the sharp barriers between school and afterschool. Typical of such educational practices are the enthronement of interest as a mainspring of effort, the child-centered school and curriculum, the project method, the socialized recitation, the various forms of unit and contract plans, the stress upon certain outcomes of laboratory work, the flexible curriculum and course of study, and the increased attention given to the development of scientific thinking and attitudes.

Rightly or wrongly, science teachers have always felt that many of the important objectives of science teaching are either difficult or impossible of accomplishment in the somewhat artificial atmosphere of a classroom. Throughout the history of our profession, we have turned to the club for the most satisfactory realization of the aims of science teaching.

We doubt if very many present here today are familiar with a publication called *The Science Teacher*. The first issue appeared in January, 1898, and the fifteenth—the last, as far as we have been able to determine—in October, 1899. "Devoted to the interests of science teachers in secondary schools," the Journal printed articles, furnished news and conducted symposia on what were then the vital problems of science teaching. To those of us who feel that much progress has been made in the solution of our teaching problems, it may come as something of a shock to learn that teachers then were also much concerned about the science sequence, effective demonstrations, pupil experiences, scientific thinking, and the individual differences and interests among pupils.

One article in particular is pertinent to the subject of this paper. In a discussion of the value of laboratory work, the writer of 1898 bemoans the fact that uniform state requirements and examinations force him to a rigid program of book-work and cramming. In order to engage in *real* science teaching, he steals the time for it in one way or another, often meeting his pupils after school hours. Describing the spirit of this extra-curricular work, he says, "The book-sick young person goes into a laboratory as a boy into water on a hot summer's day. It is a refreshing, invigorating, and an ever new world. There he not only *thinks about* problems, but he *feels* them. He becomes strong in what was probably his weakest point." Thus a science club was born.

Examining the science education literature in *School Science and Mathematics* from about 1901 to 1921, one finds a slow but steady increase in articles dealing with club work. The same problems and the same teaching objectives were compelling teachers to turn to the club as a solution of certain educational problems. In 1921, the writer of this paper published a study of a series of

experiments with science clubs in the Horace Mann and Speyer Schools of Teachers College, Columbia University. Utilizing instruments of educational measurement then available and applying all the statistical safeguards possible in such studies, he attempted to measure different educational outcomes in pupils divided into four groups:

A. Pupils pursuing curricular work in elementary science, who were also members of a science club.
B. Pupils pursuing curricular work in elementary science, who were not members of a science club.
C. Pupils not pursuing curricular work in science, but who were members of a science club.
D. Pupils who were neither pursuing curricular work in science nor were they members of a science club.

In round numbers and averaging a large variety of measured outcomes, the relative achievements of the four groups are best represented by the numbers: A – 71; B – 49; C – 44; and D – 18.

In other words, club work alone compares favorably with, if it does not surpass, class work alone. Certainly, the combination of club and class is markedly superior to class work alone.

Since the publication of this study, science education literature has more than ever found a place for material dealing with science clubs. A recent bulletin of the University of Illinois, written by Astell and Odell, lists more than 400 articles and studies, the very great majority of them written in the last five years.

The high schools of New York City, in common with the schools of other cities, have shown keen interest in after-school activities for their pupils. About six years ago, The American Institute, recognizing this interest and wishing to give it organized opportunity for development, initiated the Children's Science Fair. The Fair has grown to a point where it is regarded as one of the most important projects in progressive science teaching. Also, it has, in the last two years, given rise to an organization called the Junior Science Clubs.

Time does not permit an extended description of the Science Fair; but, in order to present adequately the club movement, it is necessary to introduce a few of the salient facts concerning the project from which sprang this effort to capitalize pupil interests in extra-curricular science.

The Children's Science Fair is one of the many activities of The American Institute of the City of New York. Founded one hundred and five years ago, this organization has for more than a century served progress in science and in science education. It assisted agriculture when little was known about scientific farming; it held annual Fairs which were forerunners of the expositions now held by almost every branch of art and industry; it brought to the attention of the public innumerable inventions, including the Morse telegraph, the McCormick reaper, the Singer sewing machine, the Hoe printing press, the Bell telephone and the Remington typewriter. Men of the type of Horace Greeley, Daniel Webster, Henry Clay, A. T. Steward, S. F. B. Morse, Ezra Cornell and Thomas Edison were among its active members and executive officers. Today, the same purposes and the same spirit activate the work of the Institute. Now, as ever, it offers a place where scientist and layman can meet to discuss the problems which affect them both.

In 1928, the Institute proposed an experiment in the education of young people in science. It took the form of a Children's Science Fair and was included by the New York State Department of Agriculture in its approved list of county fairs. A plan was developed whereby the boys and girls of New York City are invited to enter science projects in a competition for prizes. The exhibit is held once a year in Education Hall of the American Museum of Natural History. A Plan Committee of science teachers, educational administrators and laymen assist and advise with the Institute staff of workers and help determine educational policies. Early in June of each year an announcement booklet is sent to all principals

and teachers, setting forth the conditions and suggestions for the Fair to be held the following December. The booklet groups all exhibits around ten centers of science interest, as follows: Stars and the Solar System; Earth Studies; Plant and Animal Life; Biology; Physics; Chemistry; Health; Conservation; Industries; and History of Science.

Within each center of interest, the competition is open to children of all ages and grades; but the prizes are awarded according to age-grade groupings among the entries actually received. Projects may be entered either as Individual Exhibits or Group Exhibits. Schools and Clubs are independently eligible to submit their work; but the number accepted from each organization is based upon school population. Twenty judging committees are selected, ten for group exhibits and ten for individual exhibits. Each committee is composed of five members: one scientist, one layman, one senior high school teacher, one junior high school teacher and one elementary school teacher.

The sixth Children's Science Fair closed a few weeks ago. There were exhibited more than 500 projects—all that the Hall can hold. These represented the efforts of 10,000 children of all ages and grades, in 200 different schools, working under the guidance of 700 teachers. Since last June, pupils and teachers had planned and experimented in preparation for the Fair. Principals made the Fair a subject for staff conferences as did many district superintendents. Several schools held elimination contests for selecting the best exhibits. During the week of the Fair, 50,000 visitors came to study the work of the children; classes in teaching methods were assigned to study the exhibits and to write reports; science teacher clubs held special meetings for the purpose of examining and evaluating the Fair; children were sent to Education Hall for material for composition work; science clubs staged a Science Treasure Hunt among the exhibits and parents and laymen flocked to the Fair by the thousands.

The Fair is more than an incident lasting for a week or two during the school year. Individual pupils and groups of pupils plan their projects during the spring semester and work upon them steadily throughout the year. Many continue their efforts during the summer vacation. Since the projects originate in the materials of the curriculum, class work is integrated with and influenced by the program of the Fair. It is important to note that these pupil activities are rich in concrete science experiments. Whether it be the chief purpose of science teaching to interpret environment, build generalizations or develop thinking habits, participation in the Fair provides the raw materials out of which any of these aims are possible of achievement. Thus, the Fair becomes a valuable extra-curricular agency with which to supplement the curriculum.

As one travels through the hall where the hundreds of exhibits are gathered, one can not miss the spirit of vital activity which emanates from the display. Each item is the concrete result of a series of experiences in science. Thousands of children have planned and worked and thought in the field of science. In its entirety, the exhibit represents a program for teaching science in an environment such as New York City provides.

In the spring of 1932, the officers of The American Institute recognized the need for an extension of the Science Fair activity in the direction of after-school activities in science. In so many instances, the boys and girls who prepared exhibits for the Fair continued their science interests in science clubs. Often, however, such clubs did not meet the needs of children for want of effective leadership, proper programs of activity and sufficient materials and facilities. In order to solve this problem, the Institute called together a large group of educators for a general discussion. Out of this grew a Plan Committee which has initiated a tentative

program. The following general aims were adopted:

1. To encourage and assist in the organization of science clubs among boys and girls.
2. To develop a service for science clubs which provides an outlet for science interests among young people and which guides these interests into proper channels.

With the assistance of the office staff, a program was developed and announced chiefly to science clubs, in junior and senior high schools. On the strength of this announcement alone, more than 100 science clubs registered. As the program took shape, more than 200 clubs, each with an adult sponsor, indicated a desire to take part. Several types of activity were undertaken during the first six months, as follows:

1. *The March of Science.*—This is a bimonthly publication sent to club sponsors and to officers of every registered club. The leaflet contains material that is of direct interest and value to clubs. Ideas for programs, club news, a science-events calendar, places for clubs to visit, projects and experiments, and other suggestions of this type are attractively set forth for those seeking help and guidance.

2. *General Demonstration Meetings.*—Outstanding men of science, skillful in presenting science ideas through demonstrations, appear before large audiences drawn from all clubs. Two such meetings were held during the first semester. Each was attended by 1,200 boys and girls. Apparently, only the capacity of the hall limits attendance of this type. The guiding thought behind these programs is to center the material presented around a science theme to which both the physical and biological sciences can contribute. Another important aim in these general meetings is to stimulate individuals to experiment themselves along lines set forth by the speakers.

3. *Zone Meetings.*—New York City is rather far-flung, geographically. It becomes necessary, therefore, to arrange for local meetings in which several clubs coöperate. The programs for these meetings are usually of the demonstration type and are given in a high school auditorium, with the home club as host. Teachers, scientists and pupils themselves appear on the program. Some of the zone meetings are large, while others are small. Five zone meetings were held during the first year.

4. *Libraries of Club Papers.*—These consist of mimeographed bulletins of information dealing with various aspects of club work. As they are prepared, an announcement is inserted in the *March of Science* that copies are available for the clubs that wish them. Among the papers thus far prepared are: A Typical Club Constitution; A Point System for Club Work and Programs; A Bibliography of Books; and several detailed instruction sheets for projects and experiments.

5. *Speaker and Apparatus Exchange.*—Through the columns of the *March of Science,* clubs are informed of interesting speakers who are willing to address clubs and put on programs for them. These speakers include engineers, teachers, professors of science and also boys and girls who have given successful talks and demonstrations before their own clubs. Also, clubs advertise in the *March of Science* such facts as "We have a photo-electric cell which we shall be glad to lend to any club in exchange for the use of a telescope."

After about six months of this program of activities, the Institute decided to test club interests by requiring membership and the payment of one dollar per semester per club, in the form of dues. One hundred and seventeen clubs responded and became full-fledged members.

The same program was continued with this group of clubs, with one addition that furnished a grand climax of the year's activity.

6. *The Science Congress.*—In general, this program was modeled after the meetings of the American Association for the Advancement of Science. During the morning session on May 20, 1933, there were held eight section meetings as follows:

Group I. Microscopy (3 demonstrations)
Group II. Biology (Senior) (4 demonstrations)
Group III. Chemistry (4 demonstrations)
Group IV. Photography & Light (4 demonstrations)
Group V. Applied Physics (Senior) (3 demonstrations)
Group VI. Applied Physics (Junior) (4 demonstrations)
Group VII. Biology (Junior) (4 demonstrations)
Group VIII. Physical Science (Junior) (5 demonstrations)

Every one of the 31 demonstrators and speakers was a pupil member of a science club. They prepared their own experiments and were assisted by other pupil members. In the audience were invited adult scientists and laymen. Those who attended these meetings were amazed at the proficiency and skill shown by the boys and girls. They held their audiences in a way that they seldom are able to do when reciting in class.

The afternoon session was devoted to a general meeting, attended by over 1,000 boys and girls. Here, the chief speaker was a physicist of note who knows also how to speak to young people. Few who were present at this meeting will ever forget the perfection of Dr. von Nardroff's demonstration talk on "The Physics of Sand."

It may be of interest to mention at this point that the first year's activity attracted wide attention not only among school people, but among various social and educational agencies. Y. M. C. A.'s, for example, applied for our service and the Police Department, through their Crime Prevention Bureau, asked if we would not help them to organize science clubs, among delinquent boys and girls. An attempt to provide such help was made, through a course in how to lead science clubs, given to about thirty police officers. Further steps in this field of work are being planned.

The second year of Junior Science Club activity began last fall. To date, membership has reached a total of 178 clubs, each with a teacher sponsor in charge of about thirty members. Judging by the filled out questionnaires which each club files with the office, the 178 clubs come in about equal numbers from the junior and senior high school levels and are interested in every one of the major fields of science.

The Plan Committee is still experimenting with various types of activity, in order to determine which meet the greatest response and which seem to provide the greatest amount of educational return. The *March of Science* has been retained; as have all the other five fields of activity previously described. In the case of General Demonstration meetings, we have divided the programs into two age groups and into the biological and physical sciences. We hope, in this way, to fulfil the chief function of these programs which is to stimulate the audience to undertake individual projects, as a result of the meeting. This can be done better by a speaker if his audience is more homogeneous as to age and interest.

In the case of zone meetings, we are now planning to divide the city into twelve zones, based upon transportation facilities. In each zone there will be at least one large high school building, with facilities for demonstration programs; as well as one interested sponsor to provide a nucleus for organization.

Our Speakers' Exchange is being extended to include prominent men of science, industry and education, many of them drawn from the adult membership of The American Institute.

Also, a committee will soon be at work developing and extending our library of projects and experiments; with special emphasis upon clubs in the Junior High Schools.

Two additional elements in the clubs program were developed this year which possess great possibilities:

7. *Museum Courses.*—The Plan Committee feels that many of the educational agencies in the city are not sufficiently utilized. We, therefore, approached two of the museums, the American Museum of Natural History and the Museum of Science and Industry, with a request for special lecture courses to science club members. Both museums were glad to coöperate and five such courses were organized, as follows:

Course 1.	Aviation	(3 sessions) (2 sections)
Course 2.	Railroads	(2 sessions) (2 sections)
Course 3.	Electricity	(5 sessions) (2 sections)
Course 4.	Technique of Making Habitat Groups	(6 sessions) (1 section)
Course 5.	Nature Handicraft	(5 sessions) (1 section)

Each club was given an opportunity to send two members to one course. The courses are now completed and they seem to have been both popular and educationally worth while. We hope to repeat the series of courses next semester.

8. *Field Trips for Sponsors.*—Field trips are successful when led by capable and qualified leaders. Hence, the Plan Committee has attacked the problem by organizing first a series of trips for sponsors, led by six outstanding leaders in New York City. It is hoped, that our sponsors will themselves repeat these excursions with their clubs, as the possibilities in and the techniques of leading field trips become better understood. The response, thus far, has been encouraging.

In closing, we wish to enumerate several of the more important problems which appear to affect the success or failure of a science club. Unless a central organization like the Junior Science Clubs of The American Institute can help clubs to meet these problems there is very little reason for its existence: (1) The sponsor; (2) Adjusting the type of club to the interests of the members; (3) A workable constitution or other form of business organization; (4) Suitable meeting room and facilities; (5) A well-rounded program of activities; (6) Proper club-class relationships; (7) A certain minimum of funds; (8) A technique for discovering desirable places to visit; (9) A means for making contacts with other clubs and speakers; (10) A means for retaining the interest of members that graduate.

Finally, and looking forward to the time when science club work will assume an integral part of the science teacher's work, we wish to present for consideration several propositions: (1) That science teachers' associations undertake the task of coördinating the science clubs in their respective localities, along the lines developed by The American Institute in New York City; (2) that teachers' colleges devote more attention to the development of sponsors for science clubs; (3) that a coöperative movement be initiated for developing a library of bulletins on science club techniques; (4) that a science publication be developed for pupil members of science clubs; (5) that, in all of the proposals listed above, adequate representation be given to the point of view of the club sponsor and the curricular needs which club work must serve.

SCIENCE AND NATURE IN THE INTERMEDIATE GRADES*

THEODORA AGATHER
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During the past fifteen years there have come into our schools, elementary and secondary, as well as colleges and universities, many new methods of instruction, new subjects, and activities, some of which have been termed frills or fads. In the high schools and colleges these specialized subjects are taught by experts, men and women who have spent years in preparing themselves to teach in their particular branch. The introduction of the so-called frills has made the work of the high-school teacher highly specialized, so that an instructor who fifteen years ago spent the day teaching algebra, English, basketball, and agriculture, today may teach five classes of sophomore English.

How different is the task of the elementary teacher. The introduction of each new activity only extends the boundaries of her field. If she would be a successful sixth-grade teacher, she must have a fundamental knowledge of geography, history, and children's literature. She must be a master penman, a fairly good artist, somewhat of a musician, and a hygienist. When Jimmy appears with a woollybear caterpillar or Johnny returns from a week-end trip with several cadis worms, his teacher will find it not amiss to be acquainted with insect metamorphosis. Occasionally some boy in the intermediate grades will bring to school his highly prized collection of rocks, including quartz pebbles, agates, conglomerates, and specimens of sedimentary, igneous, and metamorphosed rocks. At such a time his teacher will be grateful for any knowledge of geology which she might have acquired. In the fall of the year a great variety of leaves and seeds are brought into the schoolroom. Again the teacher, well versed in the plant world, will utilize such material in the teaching of plant propagation and extinction. The average classroom in an elementary school today surpasses the three-ring circus in diversified activity.

Within the last decade, the teaching of nature and science has been introduced into the elementary schools in many of our cities. Nature and science—what a boundless realm! Shall the grade teacher be expected to carry this additional burden, if such you choose to call it?

Should we not rather ask ourselves: Can we afford to omit this most valuable of studies? Is it not our duty to acquaint the child with his surroundings—to teach him to understand the significance of the world about him? Is there anything in the curriculum of the elementary school more vital than the teaching of conservation? We must teach children to appreciate our forests, to feel the need of protecting the woodpecker, the trillium, and the deer. Or shall we allow them to go the way of the buffalo, the passenger pigeon, and our own state flower, the moccasin? Yet, conservation is only one of the important purposes in the teaching of nature and science. Through this field we awaken in children a keen faculty of observation, develop in them the ability to make comparisons and do scientific thinking, and lead them to a true appreciation of their surroundings. Boys are encouraged to experiment with such forces as electricity. In short, science greatly enriches the lives of our children.

After all, the world around us consists not so much of figures which we learn to cope with in arithmetic, nor of verbs and

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infinitives, but our world is full of interesting life—trees, birds, millions of insects, and waters which abound in a multiformity of beings. When one observes how keenly interested children are in an aquarium, and with what eagerness they will ask questions about a newly acquired specimen, one cannot but wonder at the indifference of adults towards the biological world. Such wonderful phenomena as sun dogs or a Minnesota snowstorm are taken as a matter of fact. Although the radio and aeroplane have but recently come into existence, they excite but little curiosity among adults. No doubt as children these adults were curious about the mechanism of a steam engine or a cuckoo clock, but the majority of them were adults before they learned the secrets of these mechanical mysteries. There is little question that children of the past generation were just as interested in the milkweed caterpillar as our children of today, but there was no one to teach them that this so-called worm would build himself a chrysalis more beautiful than any jewel ever worn by kings, and from this would emerge the monarch butterfly which might migrate as far south as the Gulf of Mexico for the winter and return to Hudson Bay in the early summer. Instead of being encouraged in his natural curiosity, a child was more likely to be told "to drop that ugly worm." Under no circumstances was he allowed to bring his insect friends beyond the porch. Most of us remember stories similar to one told of the toad: He must never be touched, for such an act would cause the offender's hands to be covered with warts. No wonder boys and some of the more daring girls of the past generation killed many toads, never realizing that they were destroying a valuable garden friend.

To be sure, we do have nature lovers among adults. Notwithstanding the fact that some of our more selfish hunters and fishermen take great delight in boasting that they never return from a hunting or fishing trip without their quota of partridge or wall-eyed pike, yet the true sportsman is as much interested in protecting our fish and game as the game warden himself. Our fish and game laws are no restraint on the far-sighted sportsman, who will never disturb the female pheasant nor set out a series of fish lines before retiring. Then, too, there are the horticulturists, forest rangers, game wardens, scientists, and such organizations as the Isaac Walton League and our National Garden Clubs, all of whose services to mankind cannot be overestimated. However, these are but a handful to ward off forest fires, hosts of pernicious insects, blights, and parasites, not to mention the wasteful destruction of man.

Since the children of today will be the men and women of tomorrow, let us not neglect the opportunity of awakening in the youth of our land a true appreciation of our country's resources. These boys and girls who will be the citizens of tomorrow will do the voting. They will be the legislators. We hope they will not allow the unscrupulous waste of our forests and wild life of which the past generations have been guilty. May they know the value of reforestation and reclamation. May they realize that the work carried on by the departments of agriculture and the entomologists of our country will net great returns, and that the extermination of the corn borer, grasshopper, or cotton boll weevil is of great benefit not only to the farmer and to the people of the localities where these insects are prevalent, but that the eradication of such pests is of service to the whole human race. It is the privilege of the teachers of today to so influence the future citizens of America that our country will benefit by the mistakes of past generations. Let us make the best of this opportunity.

Those of us who have worked with Wild Flower Preservation Societies, Audubon and Tree Clubs, know how easy it is to enlist the children of America in our cause. Four years ago we organized the first Wild Flower Preservation Society in our school. It consisted of about thirty boys and girls

from the fifth and sixth grades who met for twenty minutes twice a week. One of the projects carried on by this club was the making of a wild flower garden. Mrs. Fredrickson, the principal of our school, allowed us to use a shady plot of ground about five feet by three feet. The boys spaded this area, removed about twelve inches of surface soil which was poor, and replaced it with leaf mould obtained in the woods near by. Most of the plants which were put into the garden were taken from wooded areas in the vicinity of Minneapolis. They were procured by club members or other children and adults interested in the garden. Soon we had seventeen varieties including some of our rarer plants, such as the trillium and maidenhair fern, as well as such common varieties as the wild geranium. The boys painted the names of the various plants on small wooden markers which they put into the garden so that all plants could be easily identified. A committee was appointed by the president of the club to care for the garden. Another committee reported on the growth of plants, told which plants were blossoming, and which had gone to seed. There was a publicity committee which rendered valuable services. They were especially concerned with enlightening the rest of the children of the school as to what flowers should never be picked and which should be picked sparingly. A member of the publicity committee wrote to the National Headquarters of the Wild Flower Preservation Society in Washington, D. C., for literature which proved to be very valuable. The printed matter obtained included six copies of the outdoor code, which was memorized by every member of the club. After a discussion of each point in the code, four children volunteered to prepare talks in its defense, and presented their ideas to the fourth, fifth, and sixth grade rooms in the school. The six placards were posted on the bulletin boards in the corridors and in some of the intermediate rooms in the building.

The secretary of the club obtained copies of laws protecting wild flowers in Minnesota and Wisconsin. It was decided that our own state did not afford adequate protection for wild flowers which are better guarded in our neighboring state.

The children became so enthusiastic over their garden that a number of them planted gardens of their own at home. They reported on these at various times. Soon several children brought the news that their playmates in the neighborhood were also making wild flower gardens. Now members of the club were up in arms. All were quick to see that their gardens might prove a menace to the plants we were endeavoring to shelter. The children voted to discontinue their raids on the woods. One girl who was unusually sensitive returned all of her specimens to their natural habitat. The question arose whether a wild flower garden was the best way of teaching others to know and appreciate our wild flowers.

Within two years after the planting of our garden, all of the children in our Wild Flower Club had left our school, but they had learned a valuable lesson from the plants under observation. They were delighted to see the hepatica appear so early in the spring and to find their plant a mass of furry little blossoms at almost freezing temperatures when the snow had hardly disappeared. They were interested in finding out whether blossoms or leaves appeared first in the various plants, what kind of fruit developed from the blossoms, and which plants were most adaptable to their new environment. They could be shown why picking the flowers of some plants would not disturb their growth in the least while gathering blossoms of plants whose leaves grew on the flower stalk would cause the destruction of such plants because the food-producing organs were plucked with the blossoms. Lessons learned from the garden served as the basis of many a lesson in language and social studies. The fact that the blood-root and jack-in-the-pulpit had disappeared from our garden in less

than eighteen months while the wild geranium had spread itself over twice the area allotted to it made acclimation easily understandable. With very little questioning, the children could reason out why people could move four thousand miles westward and live comfortably in their new homes as did many of our European immigrants, and yet by traveling two thousand miles south, one accustomed to a temperate climate might lose his life. The seemingly insignificant fact observed in the garden was the stimulation for a series of interesting reading lessons on the subject of the Panama Canal. From their selections the children listed the reasons for the French failure and for the astonishing success of Roosevelt and the American doctors and engineers in overcoming obstacles in the tropics. It was a simple matter to understand why the American government imported natives of Jamaica, Martinique, and the Barbados to do the manual labor in the construction of the Canal. So the little garden had brought out scientific principles which formed the background for studies of climate and its effect upon the habits peculiar to races, flora, and fauna of certain areas.

From the Minneapolis Public Library we obtained beautifully colored lantern slides of the wild flowers of Minnesota. From the lecture material which accompanied the pictures the club members prepared talks which they gave in the school auditorium before a large audience of children and adults.

At the invitation of the secretary of the Flower Club, an instructor from the Department of Agriculture at the University of Minnesota, graciously consented to give an illustrated lecture on the wild life of Minnesota in the auditorium of the school. The pictures were excellent and the lecture very instructive.

With money obtained through a candy sale, the Wild Flower Club subscribed to the *Wild Flower Magazine* published by the Ohio Chapter of the National Wild Flower Preservation Society. The children were much interested in finding out that measures to protect our wild life were being taken by state legislatures from all sections of our country as well as by governments of countries from all quarters of the globe. Such articles as "The Showy Lady's Slipper," occurring in the April issue of 1930, and "Certified Christmas Trees" in the January issue of the same year, were the subjects of interesting discussions before the club.

As nearly as we could ascertain, the members of the Wild Flower Preservation Society adhered strictly to the junior Chapter pledge which they signed upon becoming members. Reports from parents proved that these boys and girls had become veritable apostles in their zeal to preserve our wild flowers and trees.

While many of our fifth and sixth grade children had become members of the Wild Flower Preservation Society, others chose to join a Tree Club, and still others entered clubs for the study of insects or stars. Each club had a fifth or sixth grade teacher as advisor. Through informal talks and programs presented in the auditorium, the various clubs imparted to the children of the intermediate grades what they had learned through careful study and research. A fifth grade class demonstrated a variety of time-telling devices, such as the clepsydra, or water clock. This class also constructed a sun dial which was placed on the school grounds. Another fifth grade, after a thorough study of Minnesota weeds, presented to the school a fine collection of weed seeds and leaves. In the school auditorium a Star Club dramatized Greek myths of the stars and constellations. These clubs also made lantern slides for the school.

Several years ago fifty-two of our children were taken by bus to visit the museum in the Zoölogy Building at the University of Minnesota. For an hour and a half they listened spell-bound to Mr. Kilgore, who related many fascinating incidents about the animals exhibited and talked most interestingly on the birds, mammals, and

reptiles, which were shown on the screen. The day following this visit the children talked enthusiastically about the intelligence of the beaver, the remarkable method employed by the mourning dove in feeding her young, and numerous other facts which they had learned. But above all they seemed impressed by the fact that there was no longer a passenger pigeon. Many questions were asked: How was it possible to kill off this bird which had been so numerous? Why did the game wardens allow such wholesale slaughter? Was there no way of bringing back the passenger pigeon? This was an opportune time for the organization of a Bird Club, and we have since that time had several Audubon Clubs which have won for our birds many devoted friends among the children throughout the school and the parents of our district as well. Fathers have helped their boys make bird houses and bird baths, wonderful substitutes for the old-time sling-shots. One of our Audubon Clubs put up a bird feeding station at the school, near which members of a Tree Club planted a group of fruit trees to invite the birds. These trees included an apple, a plum, a cherry, and mountain ash. The recent book *The Birds of Minnesota,* by Roberts, gives convincing evidence of the dire need of teaching bird preservation. We hope the children of the next generation will not have occasion to feel incensed over the disappearance of the marsh hawk and screech owl, both of which are birds of prey and devour countless mice, gophers, grasshoppers, destructive moths, and caterpillars. In 1925 the legislature of our state removed all protection from owls and hawks. These birds have never been really numerous, and today have become quite rare. When we consider how numerous and prolific was the wild pigeon, it is easy to guess the fate of our hawks and owls.

Statistics prove that the deaths of millions upon millions of our birds result from unnatural causes. How shall we remove such causes except through education?

At present we read about a water shortage in the region of Breckenridge, Minnesota. Only through legislation and proper control of our water supply can we insure other regions against such disaster after a period of drought. If the members of our law-making bodies have not been awakened to possible misfortunes which threaten the citizens of certain areas, they are not likely to be interested in safeguarding the welfare of those citizens. It would seem that nature and science should be made one of the essentials of our curriculum.

The nature and science work in the intermediate grades in our school has been carried on largely through clubs for the past four years. The children seem to enjoy the informality of these meetings. Our clubs have been almost as varied as are the fields in science. But we have learned that no field of nature is "sufficient unto itself." We cannot study birds without learning a great deal about insects, trees, and weeds. Neither can we study trees without learning something about climate, soil, and topography. Nature and science are closely allied with our social studies. Recently a group of eleven boys who comprised the Rocks and Minerals Club in our room made a thorough study of amber in connection with our study of Poland. After they had given reports on the formation of this fossil, where it is found, and how obtained, the president of the group exhibiting a small pipe, remarked, "I didn't know that the stem of this old pipe had such an interesting history. My Dad said that the bowl is made of meerschaum. The next thing I want to find out is just what that is, and where it comes from." The same group of boys contributed much information on the industrial region of the Ruhr Valley and the mines of the Sarre-Basin.

There seems to be something about nature and science that appeals especially to a boy's interest. Perhaps it is because boys spend so much time out of doors and have witnessed some of the wonders in nature that most of humanity never experi-

ence. Boys frequently tell of having seen a snake shed its skin, a turtle bury her eggs in the sand, or a swallowtail caterpillar push out his horns when molested. They are as enthusiastic in relating such experiences as they are in describing a Wild West Show. Such criticism as has been meted out to boys that they are not as good students as girls, that it is more difficult to hold their interest than that of girls, and that boys are largely the discipline problems certainly does not hold true in the nature study work. In the elementary schools of our city there are five times as many boys failing as girls. Yet psychologists tell us that the I.Q.'s of boys compare favorably with those of girls. Perhaps we have built up a curriculum which appeals to girls more than to boys.

Only recently the principal of our building visited a language lesson in our room. The children had written stories on the board for class correction. After the lesson Mrs. Fredrickson made the comment that the story written by Jack Miller was the best piece of work she had seen him do in the three years in which he has been in our school. Jack has been quite a problem during most of his school life. His teachers agree that he was not really a bad boy, but his lack of interest, careless habits, and irresponsibility made him a nuisance in the schoolroom. Correcting or reprimanding him only added sullenness and defiance to his undesirable traits. His school work was poor, and twice he has had to repeat a grade. Within the past four months Jack's attitude has undergone quite a change. He has shown a great liking for his club work. Last fall he was a member of a Tree Club and made the finest collection of leaves in the club. At the same time he brought to school insects for the Insect Club, black soil for our plants, and white sand for the aquarium. At present he is president of the Electricity Club, in which he has been intensely interested. His interest has carried over into his other work as well, and since the first month of school he has not failed on a single assignment. His mother has said this is the first year since entering kindergarten that Jack has shown any liking for school. If nature and science were to be dropped from our curriculum, it is to be feared that Jack's interest would wane and school might again be a dull place not only to him, but to many other children, especially boys.

Two years ago we had in our sixth grade Electricity Club a group of twenty-five boys which included four boys of superior intelligence, three dull normals, and one boy who bordered on being subnormal. The I.Q.'s of this group ranged from 80 to 147. In arithmetic, language, or reading, such a wide range of I.Q.'s would necessitate much individual help from the teacher and would call for a variety of drills to meet the individual differences. Even with the most painstaking preparation on the part of the teacher, the results for her as well as for the slower pupils might occasionally be discouraging. Yet in the Electricity Club none of the boys needed any special stimulation and none felt discouraged. All were so eager to demonstrate such apparatus as a home-made telegraph set or a self-assembled electric motor that the twenty-five minutes allowed for club meetings proved inadequate. In addition to this time, the boys spent many hours constructing electrical apparatus or trying out some experiment, such as electro-plating. Much of this work was done at school early in the morning, during the noon hour, or after three o'clock. Most of the boys also worked at home where they were assisted by their fathers and older brothers who had taken courses in electricity in the Junior or Senior High School. The boys of superior intelligence had more time to devote to their study of electricity, but even the less gifted made valuable contributions. Carl, whose I.Q. was 80, seldom spelled more than eight words out of twenty correctly, no matter how much help he was given, but in a short time he had learned the Morse Code well enough so that he was

able to send and receive telegraph messages. Although he usually failed on a reading assignment of sixth grade difficulty, he was able to make an electromagnet without any help in interpreting the printed directions from a book by Bertha M. Parker, written for the sixth, seventh, and eighth grades. The only person who had any difficulty in keeping up with the class was the teacher, whose knowledge of electricity up to this time had been very meager.

Three months after the organization of our Electricity Club, seven of the boys were invited to visit the biennial Electricity Show at the University of Minnesota. All of the boys were eager to go, but the invitation limited the number to six or seven. For four hours these boys followed a student who acted as their guide and explained hundreds of exhibits to them. The boys listened intently and asked many questions. They were fascinated by the very first electrical device, a machine which automatically counted all visitors who entered the building, and flashed the numbers on a glass slide, and they were just as interested when they reached the last exhibit, a display of man-made lightning ranging from 70,000 to 150,000 volts.

For many weeks the boys talked of little else. Each one chose to write a composition for the language class on the exhibit which he thought most interesting. The following is a copy of one of the compositions:

THE PHOTO-ELECTRIC CELL

To me the most interesting exhibit at the electrical show was the photo-electric cell. The part it played in transmitting sound was very interesting. A neon tube was connected to a phonograph. When turned on, the light passed through a magnifying glass, and this beam shone through a lens about six feet away into a small opening in an iron box which contained amplifying tubes. The light first fell on a tube called a photo-electric cell. This looked like a radio tube but was transparent on the side nearest the opening. The photo-electric cell works like the human eye. The sound from the phonograph traveled over the light beam and was picked up by the photo-electric cell. After being amplified many times, it was carried over wires into a loud speaker. From this speaker could be heard the music of the phonograph.

All of the compositions were sent to the chairman of the Electricity Show, who had become quite interested in the "Future Electrical Engineers," as he called these boys. This student, who was a senior in the College of Engineering, included the compositions in his report on the Electricity Show.

Perhaps the most beneficial result of this visit was the fact that these sixth grade boys planned an electricity show of their own. The suggestion for the same came from a boy who was keenly disappointed because he had been among those who did not see the show. Never did this group of boys show a better spirit of coöperation and never did they plan more carefully or work more diligently than in preparing the exhibits which they later explained to the teachers and most of the pupils of the school, as well as to outside visitors.

Our science clubs in the intermediate grades have opened to the children new channels for observation, study, research, experiment, and construction. Yet, the work carried on by our clubs is a mere introduction to the great Out-of-Doors and forces in nature. We hope that our boys and girls will learn more and more about our universe, and that they shall come to the realization that:

"To him who in the love of nature holds
Communion with her visible forms, she speaks
A various language; for his gayer hours
She has a voice of gladness, and a smile
And eloquence of beauty, and she glides
Into his darker musings, with a mild
And healing sympathy, that steals away
Their sharpness, ere he is aware."

A SCIENCE CLUB TO VITALIZE SCIENCE TEACHING*

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To the experienced and alert teachers of science, the title of this paper may read much like a formula for making steam hot or ice cold. No such suggestion is needed for those who are familiar with the broad field of science materials at every age and grade level, and the wealth of interesting demonstrations that are possible. It is rather to beginning teachers of science and students who are in training to become science teachers that this paper is addressed. A preliminary survey by the writer has disclosed that in many sections, and especially in the smaller high schools, not as much use is made of stimulating teaching devices as the teaching of science would permit.

Science teachers may consider themselves fortunate because of the wealth of interesting materials the subject itself presents. There are the ever changing phenomena of the heavens; the story of the formation and development of the earth; the great out-of-doors with its myriads of living forms all adapted to their own environments and striving to perpetuate their kind; the intricate and minute world revealed under the microscope and the countless other interesting and ever new facts and phenomena. Add to the subject-matter the spirit of the boys and girls of the adolescent age who bring to the subject a natural interest, curiosity and enthusiasm, and the teaching situation is almost ideal. No teacher should fail to make the very most of such opportunities of interesting material coupled with the boundless enthusiasm of youth. Perhaps every science teacher needs again to be reminded of the opportunities he has in these days of depleted budgets and increased teaching loads.

There has grown up comparatively recently a movement for more and more extra-curricular activities in the high school. One of the many forms of such activities is the high-school pupils' club which has been formed in almost every subject and representing nearly every line of activity. It is with the science club as an extra-curricular activity that this paper is concerned. An attempt is made to present a minimum of information concerning the organization and management of such clubs which all teachers of science should know. For many years the writer, as supervisor of junior teachers in science, has insisted that every junior teacher take an active part in the direction and management of a science club as a regular part of his training course.

The junior high-school age is the age at which boys and girls like to form clubs, it is known as the gang age, or the age of cliques, and is an age in which new social impulses stir the individual. It is, therefore, highly important that this psychological characteristic of young people be directed and turned into channels of worth-while activities, rather than to be left undirected and to result in wrong habit formation. Educators everywhere have come to recognize the full value of school clubs as a means of arousing the interest and kindling the enthusiasm of pupils. Habits of thinking and action, which are often difficult to secure under regular classroom conditions are quickly formed through the tasks the pupils set for themselves. Pupils delight in planning for themselves and are always eager to carry out their own projects.

That science clubs can be of immense value to both the individuals participating in them and to the school as a whole will hardly be denied by any one who has had experience with such clubs. For beginning teachers who have not had experience with clubs it may be worth while to enumerate some of

* Read at the 1933 Annual Meeting of the Science Section of the Wyoming Education Association.

the values which have been listed in the literature on the subject.

Olson[1] has listed the values of science clubs as given by those who have had the longest and most intimate contact with them.

(1) (Science clubs provide) a broadening and finding scheme for high-school pupils.
(2) Deepen interest in science and in high school as a whole.
(3) Supplement the class work.
(4) Pupils preside and learn how to conduct a meeting.
(5) Pupils have an opportunity to prepare thoroughly on a subject in all its phases. Teaches thoroughness of study.
(6) Learn many things they would never get in regular science courses.
(7) Improves the discipline of the school.
(8) Provides an avenue for the choice of life work.
(9) The pupil is taught accurate observation and ability to report that observation.
(10) Pupils become entirely responsible for the success of an undertaking.
(11) Club work helps make class work more effective.

Values to the whole school taken from Hunter are:

(1) Social meetings gave contact with students.
(2) The beginning of a wider scope of activity outside the school laboratory.
(3) Affiliation with a great American Museum (true in a specific case).
(4) Remedied condition in dining hall (true in a specific case).
(5) Disciplined study halls, corridors, and gymnasium.
(6) (Pupils) made good in other lines of work.
(7) (Pupils) got assembly speakers.

Many other values both general and specific may be listed. It seems to the writer that the most worth-while ones are: (1) the opportunity it gives pupils to follow their own interests, thus having both exploratory value and the value that comes with doing things for the sake of wanting to do them; (2) the opportunity it gives pupils for a broader contact with science (best served by a club of a general character; and (3) the awakening of the pupils' appreciation for, and the deepening of his interest in science.

In a very real sense a science club can be made to further the aims and objectives of science teaching. This will, of course, depend much upon the nature and purpose of the club; how it is organized and the leadership under which it carries on its activities. The general aims of science teaching as outlined by the National Survey of Secondary Education[2] in their report on instruction in science may be grouped under five general types as follows:

(1) Knowledge aims, including all kinds of useful knowledge of science.
(2) Exploration or orientation of the pupils' abilities and capacities.
(3) Abilities to think scientifically and to use the instruments of science.
(4) Attitudes toward truth and fact and of appreciation of the contribution and value of science.
(5) Ideals and habits of accuracy, persistence, truth, honesty, and self-control.
(6) Interests in science, scientific reading, nature, vocational fields, and interests which may be used to enjoy leisure time.

In the report, these type aims are broken down into more specific ones which may be applied to the separate courses or units and which serve the science teacher in his daily work. The general types of aim will, however, serve to point out what science teaching is attempting to do. Comparing the objective of science clubs with those of science teaching as outlined above, it is evident that there is a striking similarity. Numerous tabulations have been made of the objectives of science clubs each depending upon the nature of the clubs included in the tabulation. As a typical list of objectives of science clubs one may take that of Foster[3] which gives the objectives of clubs gathered from many sources.

(1) To encourage general scientific knowledge.
(2) To have every member take part in the meetings.
(3) To encourage students to present scientific ideas or information in which they are especially interested.
(4) To stimulate keener interest in the work of the regular science classes.

(5) To help the pupils to do better the things they will do anyway.
(6) To create an attitude of scientific learning among the students and by students.
(7) To develop initiative, self-reliance, and leadership in this field.
(8) To appreciate the importance of science in the every-day life of every citizen.

The organization of a club that will function is based upon several well-recognized principles of club management. Meister[4] has outlined four factors for the successful science club as follows:

(1) A club that is general in its interests and appeal rather than specific.
(2) A workable set of materials which, to a great extent, can now be supplied by the toys the boys themselves possess.
(3) A definite program of activities. . . .
(4) Intelligent leadership; the chief element of which is to set the stage so that the boys themselves will carry out the program.

Most writers on the subject are agreed that a club with general interests is better than one with specific interests. By far the most numerous are the General Science Clubs. Next in order of frequency of occurrence are Chemistry Clubs, Physics Clubs, and Biology Clubs. The more specialized ones, such as Radio Clubs, Bird Clubs, Electrical Clubs, Photography Clubs, *et cetera,* find their place of maximal usefulness in the large high schools where there are a number of science clubs and where membership in any one must be limited. The general club is certainly to be recommended for the small high school which may not have more than one science club and which would have relatively few pupils interested in any specialized field.

The club should be based upon the interests of the pupils, preferably, it should be initiated by a group of pupils. When a group of interested pupils petitions the director of extra-curricular activities or the principal of the high school for a club, plans should be made for its organization and a sponsor chosen by the principal.

Every club should have its own constitution which has been drawn up by the pupils and adopted by the club as a whole. In this matter the sponsor can give valuable help but should not dictate; pupils will readily see the need for a set of rules to govern themselves in their club meetings and activities. The constitution should cover such points as the name of the club, who may become members, qualifications and manner of choosing the officers, duties of the officers, time and place of holding meetings and regulations covering other activities of the club.

Many of the points of organization and management will depend upon the other school activities, the curricular and extra-curricular, as well as the number and kind of other clubs formed, and manner of carrying on their activities. Probably no ready-made program of organization and management will fit every club. There are a variety of organizations in use and it is probably well for the pupils and the sponsor to work out the details to meet their own needs.

The question of who may become members of the science club deserves some consideration. It would seem to the writer that the best plan is to allow only those pupils who display a genuine interest in science to become members. Under no circumstances should pupils be compelled to join a science club, or any other club, for that matter, but it should be the aim of the school to have all pupils in some club if at all possible. In schools where a number of clubs exist pupils should be allowed to become members of the club of their first choice unless that club becomes too large, in which case they may be asked to join the club of their second choice. Pupils should not elect the new members but rather membership should be based on interest and a desire on the part of the pupils to enter the club. It may be desirable to have candidates for membership present their reasons for wanting to join, together with their qualifications. These applications could be reviewed by the sponsor and new members selected by him. A point system for entering and for showing continued interest in the club has been successfully worked out by some clubs.

A science club should have a definitely planned program for the year which has been worked out by the club members in conference with the faculty sponsor. Meister[5] outlines five types of activities for science clubs which may be carried on by nearly any club.

1. *Lectures.* Usually given by pupils but occasionally by a member of the high-school faculty or by some professional man or a college professor. Lectures by students consist of the presentation of papers written by the pupils themselves and usually followed by a discussion. The work of the sponsor plays an important part in this type of activity and upon him largely depends the success of this type of program.

2. *The Trip.* The field trip or excursion made to some point of interest such as a factory, power plant, museum, or to some out-of-door point of interest is a popular activity of science clubs. The trips should be planned by the pupils themselves, who are usually alert in finding such points of interest. As a rule pupils who are not interested in a particular trip should not be required to go.

3. *School Assemblies, Exhibitions, Bazaars, et cetera.* This type of activity is a splendid one with which to close up the club work of the year. The writer has seen science clubs carry on assembly programs which were a credit to the clubs as well as to the school. On one such occasion a college professor of zoölogy gave an illustrated lecture on native birds which was enjoyed by the entire student body. Members of the science club arranged the program and one of the boys operated the projection lantern. Exhibitions, bazaars, and carnivals have been successfully carried on by clubs, furnishing amusement for the entire school and incidentally bringing funds into the club treasury.

4. *The Work Period.* This requires a science shop equipped with some tools, a bench or two and a minimum of workable materials. Such a period gives pupils an opportunity to try their hands at making things which they have themselves designed and for trying out their inventions. An occasional work period serves to add interest and to stimulate individual designing of apparatus, toys, or other devices which boys, especially, are fond of making. Some writers recommend the work period for every other meeting of the club, but much will depend upon the facilities for this type of activity.

5. *The Demonstration Program.* This type of program seems to be the most favored by science club members. There are numerous easy and interesting experiments and tricks which can be performed by pupils before the group. Each pupil should be responsible for his own apparatus and materials as well as all explanations to be made in the demonstration.

Besides the five types of activities mentioned there are many others which might be suggested, such as giving current science talks, news events, science puzzles, plays, social and recreational meetings.

The success of a science club depends more upon the right kind of leadership than upon any other factor. This factor is here emphasized because the students in training to become science teachers should have both the knowledge and understanding as well as the proper attitude toward the leadership they will be called upon to assume. The teacher who acts as sponsor of the club must give intelligent guidance to the pupils' activity without dominating the club. Pupils must be made to feel that the club is their activity and that they are managing it in all its details as well as carrying on the programs. This is often more difficult for the beginning teacher than to do all the work himself.

The qualifications of a successful club sponsor are not different from those of a successful teacher. Some of the more essential qualifications of a club sponsor are:

(1) He should have a well-grounded appreciation of nature and of the many wonders to be seen even in a commonplace environment, together with a wholesome attitude toward life and all natural objects and phenomena.

(2) He should be a keen observer, be able to draw conclusions, and in general to use the methods of science in a skillful manner.

(3) He should be so trained in the several fields of science to have an appreciation of the relation of the main courses in the science field.

(4) He must understand the adolescent mind, be able to see the problems and perplexities which present themselves to young minds, and be skillful and resourceful in suggesting ways and means of overcoming their difficulties.

(5) He must be able to teach and inspire others from an abundance of reserve information and enthusiasm. This he cannot do without being thoroughly grounded in his subject and having a deep and abiding faith in its values.

The sponsor must ever remember that his job is to direct others and to stimulate and guide without making pupils feel that he is doing things for them. The true work of

the pupils must be brought out in a manner which they will recognize as their own.

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A REVIEW AND EVALUATION OF THE CURRICULAR STUDIES PERTAINING TO ELEMENTARY SCIENCE*

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Studies prior to 1925. The early investigations of science teaching in the elementary school were concerned with the materials which children observed and with those materials in which they appeared most interested. As early as 1870, Bartholomai,[1] a German, asked the children entering his school such questions as, "Did you ever see a hare?" In the same year, Dr. Karl Longe[1] asked 800 children just entering school simple questions on scientific topics to form a basis for instruction. Ten years later, Hall[1] undertook an investigation, asking questions of first-grade children and securing 162 ideas and objects.

In 1904 Trafton[2] published a study on children's interests in nature materials. After analyzing the returns from a set of essay-type questions given to about one thousand fourth-grade, fifth-grade, and sixth-grade pupils, he came to the conclusion that the limited acquaintance of children with wild plants and animals stands out prominently. "The average number of wild animals named was 11; domestic animals, 7; cultivated trees, 4; wild trees, 6; cultivated flowers, 6; wild flowers, 3." He recommended that to adapt the subject-matter of nature materials to children's interests, such topics as size and color must serve as the entering wedge leading to the study of living things. The investigator interpreted his study as showing that as children come to know more about animals they manifested a tendency to be more impressed with the habits and other activities, a fact which the investigator interpreted as indicating the line along which the child's interest is aroused.

This study is the first of any consequence in elementary science. Its value is marred by the form and subjectiveness of the questions used. Also, a number of the findings were not substantiated in later studies. This study and the two earlier ones by Bartholomai and Longe are mentioned only for their historical value.

In 1910, Libbey[3] made a comparative study of the information possessed by the following groups: a five-year-old boy; twelve orphanage children, three to seven years of age; and first year high-school pupils. He also compared white with colored pupils. His findings contributed little either to content or method in elementary science.

Further interest studies appeared in 1912. Mau[4] published a study relative to the interests in physical and biological nature materials of children in the kindergarten and primary grades. In one unit she presented to 1,988 children, (1) a pepper plant with many red berries, (2) a gray cat, and (3) a toy engine. The children preferred the cat. Mau decided that the objects used were not equally representative of the three fields of

* Martin L. Robertson, *A Basis for the Selection of Course Content in Elementary Science.* Doctor's Dissertation (unpublished), University of Michigan, 1933.

science. She therefore repeated the investigation using (1) a sensitive plant, (2) a turtle dove in a cage, and (3) two bar magnets and iron filings. The children preferred the bird. She interpreted her findings as indicating that the order of interests for boys is from animal life to plant life, and thence to physical materials; further that the order of types of interest was identification, growth and activities, adaptation, distribution, *et cetera;* also that the kind of animal and the kind of physical materials that make the strongest appeal differ at different ages. However, too much importance should not be attached to a study utilizing a few objects so widely differing in their appeal.

Downing[4] in the same year made an analysis of children's questions and observations in the magazine, *St. Nicholas.* There were 447 questions and 295 observations from 742 boys and girls. The average age of the contributing children was about twelve years. His study indicated the order of interests to be again animal, plant, and physical materials. He also found that activities, identification, and care were outstanding topics. These findings substantiate those of the Mau study and are in turn substantiated by Minley.[5] Downing's assumption that these questions were in no way stimulated and that they were, therefore, more indicative of the normal interest of children than those collected by other means seems unjustified.

In 1913, Patterson[6] published a study on the status of nature study in the elementary schools. She endeavored to determine the purpose, content, and method included in the nature-study curricula. She analyzed 20 state courses of nature study and 30 nature-study courses in large cities. In her findings she reported the purposes to be rather uniform in the many courses inspected, and pointed out that all the courses of that time included the study of plants, animals, weather phenomena and sky, physics and chemistry, and soil. She reported the per cents of the topics in the courses that dealt with plants and animals and also arranged the ten or twelve most important topics in the order of their frequency of appearance in the courses.

Several years later, Thompson[7] analyzed 82 courses of study ranging in date of publication from 1915 to 1919. He prepared a composite list of 252 topics under the heads: animals, plants, physiology-hygiene, geography-geology, physics, and chemistry. He tabulated, among other things, the frequency of occurrence of the topics by grades, by state courses, by large cities and by small cities. He found the per cents of the 82 courses that included each of the 252 topics by grades. He listed the 10 topics used most frequently in each grade and the 10 topics used least frequently. In the body of the thesis he described the type of materials considered under each topic. It appears to be a comprehensive study of practice. He wisely concluded that such materials should not be used in curricular construction except as a working list, and that there was need for the formation of definite objectives towards which these materials, as well as materials from other sources, would contribute.

In the same year as the result of a study of the adaptability of general science in the last three grammar grades, Webb[8] came to the sweeping conclusion that representative principles of specific sciences could not be effectively presented below the sixth grade. This statement would be difficult to defend at present. It was based on the inability of fifth graders to write answers to essay questions involving a vocabulary with which they apparently were not familiar. No careful studies of science vocabulary had been made at this time; in fact no science books have been based on the results of such research until recently.

In 1921, Finley[9] presented a live "mud-puppy" to 1716 pupils. After the pupils had observed the animal in an aquarium, they were requested to write all the questions they desired to have answered. The pupils in the first and second grade were allowed to whisper questions to the teacher.

After 40 days a selected group of the children were requested to write a composition on the animal. Finley found close agreement in the interests evidenced by the compositions with those of the questions. Identification and structure secured more interest than other phases generally. Interest in environment, food, life history, adaptation, classification, and geographical distribution increased in successive grades.

He extended this study by presenting a life plant, a black skimmer, and a pendulum to 827 pupils. These were presented to the classes in varying orders and a written exercise was required. Later they were asked to indicate on slips of paper the one of the three previously presented objects which they would prefer to consider again. The bird received the most consideration. This study substantiated the conclusions of Mau and Downing.

In 1924, Hillman[1] analyzed 36 state, city, and training-school courses of elementary science to determine the content of the science curriculum. He found little agreement in the courses of study. There were only six topics that occurred in the same grade in 18 of the 36 courses. He also found that much material catalogued as nature-study and elementary science was limited to the first four grades. In this study he found that the plant and animal materials were given about equal emphasis. The physical-chemical phenomena followed with secondary emphasis.

In the same study he formulated questions involving topics that occurred more than five times in his analysis and gave them to some fourteen thousand children to determine what they knew about the science content. He interpreted the results of his tests as indicating that children possess a limited knowledge of science materials. From these data, he concluded that children knew little about the principles of science that they could not easily discover without having had any kind of formal course in the subject. However, the study does not state whether or not the children tested had received instruction in science. Moreover, there is no evidence in Hillman's study that he determined the nature of the materials contributing to each topic. For example, if he formulated six questions on *Seeds* and nine on *Seed Dispersal* without knowing the definite contexts in which these topics are treated, his conclusions with respect to the information possessed by children would probably be valueless. His findings seem to agree with some of the earlier studies such as those of Libbey and Webb which point out that children know many of the factual materials without instruction and that they do not appear to have the capacity to comprehend the simple principles of science below the sixth grade. Not one of these three investigators defined the meaning of a principle. Their conclusions concerning principles, therefore, carry little conviction. There would seem to be an opportunity for investigations to determine more carefully children's abilities to comprehend science material.

Summary of studies prior to 1925. The contributions which the investigators claim for these early studies may be summarized as follows:

1. The order of children's interests in science materials seems to be the following: animals, then plants, and thence to physical materials.
2. The order of interests in animals from the lower to the higher grades is reported as follows: identification, life habits, life history, adaptations, and structure.
3. There is wide variation in the purposes of courses in elementary science.
4. The content of courses consists of biological materials to a large extent.

Studies completed since 1925. In 1921, Palmer[9] began a series of question-collecting studies through the medium of the "Rural School Leaflet" (Cornell). That of 1926 carried a composite table of the preceding five years. The findings were in the form of tables showing the percentage of the questions dealing with zoology and its various divisions, botany and its various divisions, inorganic nature, agriculture, *et cetera*. His findings indicate that the order of the nature of the questions is: habits, taxonomy, econ-

omy, ecology, definition, and morphology, with habits twenty per cent higher than the next closest type of question. In the various fields of science he found that zoology was the most important field from the standpoint of the number of questions asked, that the most important subdivisions of zoology were the invertebrates and birds, that botany was next with woody plants as the most important subdivision, that there was a wide gap before the next division, inorganic nature, and that agriculture was lowest.

Assisted by Gordon, Palmer[10] extended these studies in 1929. He grouped the questions collected by grades according to the various fields of science, and also separately according to the nature of the questions. It appeared that the order of interest by grades followed quite closely the order obtained in the larger study made over the five-year period, although fish, reptiles, and amphibians were grouped together and given apparently, therefore, a greater weight in the latter study. This is probably the most extensive series of studies that has been thus far completed. If the questions involved in these studies had been grouped under principles or major topics in the various fields, or if the classifications had been analyzed to show, for example, which habits of which animals were the most interesting, this study would have been invaluable in all subsequent research. It is of little value as now reported.

In 1926, Bagley and Kyte[11] made an analysis and tabulation of all the city and county courses in elementary science in the state of California. Their report shows that there is "little agreement either as to materials that should be included in such courses or as to the methods of teaching; and an almost total lack of investigation regarding the essentials in elementary science." Their study is a careful piece of research, indicating the range of grades in which courses are organized, and the distribution of twenty-two main topics of subjects by grades. They found that,

> In all the courses of study, there is considerable agreement that the study of "animal life" in general, and "bird life" in particular, should find a place in the first four grades. To these subjects the cities add "fruit bearers," but the counties do not follow the practice.

Their data indicated considerable variation in the placement of the other topics. The nature of the treatment of these topics in the courses did not reveal a justification for these wide variations. They also surveyed the educational literature pertaining to elementary science and indicated the instructional status of the subject.

Table C of their study indicates the time allotments of elementary science by grades.

In 1927, Craig[12] attacked the problem of the elementary science curriculum preparatory to developing a course of study for the Horace Mann School. He first established a series of objectives based upon the criteria that science should conform to those scientific conceptions which were fundamental to modern life; that it should conform to those goals that are important in establishing health, economy, and safety in private and public life; that it should conform to those facts and principles of science that are essential to the interpretation of the natural phenomena of the environment; that it should conform to the purposes of acquaintance with and the identification of the environment; and that it should conform to those goals suggestive of means of securing standards of action.

Craig presented the 82 objectives secured by his preliminary study to a group of educated laymen for ranking on the basis of their opinions of the need for these objectives in their lives. Also he secured some seven thousand questions from boys and girls of elementary school age and evaluated these objectives on the basis of their needs in answering children's questions. Next he evaluated them on the basis of the meanings developed in authoritative source books of science. He used these evaluations as a basis in building the Horace Mann Course of Study. This study is the most extensive and reliable that has been published dealing with the content of elementary science. The

technique used revealed over one hundred appropriate objectives of elementary science. This was the most widely accepted study that established objectives for science in the elementary school through the use of experimental and statistical means.

In 1930 the writer[13] verified the appropriateness of objectives secured in this matter by selecting six units from the Horace Mann Course and teaching them to fifth grade boys and girls, utilizing a carefully controlled rotation technique. One of the outcomes of the study indicated that Craig's material was entirely appropriate. More recently, units from Craig's course have been found appropriate in the sixth grade by McSpadden.[14]

In 1929, Stevenson carried out an experiment in the Demonstration School of the San Jose State Teachers' College, San Jose, California.[15] He investigated children's interests in nature materials and attempted to discover which objects in each of the science fields were of the most interest to children. His subjects were 119 children in the grades from the fourth to the sixth. He used rating sheets, questions, compositions, and observations. He interpreted his data to indicate that children are interested in nature objects; that live animals are most interesting; that the children's interests are gripped most by the unique and spectacular aspects of science; and that the interests of children vary with age. This study makes very little additional contribution although the emphasis placed upon the spectacular aspects is very interesting.

It is also fitting to include here a description of Billig's study.[16] She developed a technique for selecting and organizing "core" and "marginal" content for a professional course of science for teachers in elementary schools. It may be summarized as follows:

1. Principles of science serve as a guide in the selection of content and organization of teaching material.
2. The derivation of the elements of the content is arrived at by means of an analysis of the literature written by experts in the various fields for the specialist and the lay reader.
3. Core material is selected by means of criteria and consists of those elements which relate directly to the principles of science without which suitable realization could not be consumated.
4. Marginal content is selected by means of criteria and consists of those elements which contribute to an enriched background of experience and enable the teacher in training to secure an enlarged interpretation of the core material, and which at the same time gives him the security of preparation.
5. The elements selected as core and marginal materials were evaluated on the basis of experience and judgments of instructors who had a broad training in science and who were primarily interested in the training of teachers to teach in the elementary schools.
6. The elements were so organized into teaching units, that as teaching progresses, the simple elements will form more complex associations which will deveop gradually an understanding in the minds of the learners.

This technique was applied to one illustrative principle of science, namely, "living things survive because they are fitted to conditions under which they live and in which their structures and ways of living enable them to attain adult life and leave offspring."

This study definitely states one principle of science as the outcome of a unit of work and provides a technique of determining the content contributing to that unit on the college level. This is one of the earliest studies that emphasizes the use of a carefully stated principle as the objective of instruction. The implication with respect to the outcomes of science which teachers trained by this method would establish for the children is quite obvious.

Another worth-while contribution to science teaching was made that year by Lammel.[17] She analyzed, for topics involving scientific concepts, nine readers in grades four, five, and six. She secured 45 scientific terms. She was able to determine the meaning of 24 of these topics through a series of personal interviews with a number of children. Her topics consisted of such nouns as tree, water, man, forest, day, bird, etc. The meanings developed by her study were listed also. This is a new and valuable approach to the problem of science curriculum and should be followed by further similar studies.

As a study preliminary to the present investigation, the writer[18] attempted to combine the findings of several of these studies with the speculation of curriculum committees and to evaluate the whole.

He selected, on the basis of arbitrary criteria, four research studies and four city courses of study. The research studies were those of Craig,[12] Hillman,[1] Billig[16] and Palmer;[19] the courses of study were the latest available in the latter part of the year 1930, from Baltimore, Oakland, Denver, and St. Louis.

From these sources he secured a list of topics appropriate to elementary science. This list was validated by a jury of three elementary science supervisors, and then a relative valuation for each topic was determined by means of Curtis's statistical technique.[20]

In 1932, two additional studies of considerable importance in providing curriculum materials were completed. One was an analysis by Mathis[21] of eleven courses of study in elementary science. She made careful analysis of these courses, placing the data upon cards. She classified each idea, principle, topic, and activity, together with the grade placement. She included in her analysis a detailed list of the aims and objectives of the various courses tabulated on the basis of the objectives found in the *Fourth Yearbook* of the Department of Superintendence, N. E. A. The following are definitions of terms used in her study:

An idea is an embodiment of a conception which connotes a corresponding reality; it is an implied relationship of facts; an idea often related to an object or a phenomenon. Typical examples are: (1) Economic value of animals to men, (2) How nature cares for trees and plants during the winter, (3) Influence of weather upon man.

A principle is a fundamental, or general, truth. Examples are: (1) How animals reproduce and grow, (2) A leaf is a factory, (3) Relation of wind and weather.

A topic simply names an object or subject for discussion. Typical topics are: (1) Domestic animals, (2) Trees, (3) Climate.

An activity implies motion, action, or self-caused change. In some action there is no purpose, but this study confines activity to purposeful activity. In a sense it is schoolroom manipulation: the correlation of activity with school subjects to make them more meaningful, to hold the child's interest and impress him with the facts involved; all of these may be termed activity. Examples are: (1) Junior Humane League Organized, (2) Window boxes for the schoolroom, (3) To make a weather chart or calendar.

Her findings consist of a list of 460 ideas, topics, principles, and activities with their grade distribution and frequency of occurrence.

This study is of interest because it attempted to locate the principles involved in the course of study and also because it indicated the ideas that children could develop by using the courses analyzed.

Newland's study[22] was an extensive analysis of magazines. She analyzed the issues of the 11 most widely distributed magazines for a ten-year period to secure allusions to science either in the body of the magazine or in the advertisements. She secured over three thousand allusions to science, and her findings include these allusions with the two most common contexts in which each of the allusions occurred. The allusions are given a rank order on the basis of frequency of their occurrence. This study is included in this review because Johnson[23] found that boys and girls read the magazines in the home. His study of 1,856 boys and girls of Duluth revealed that in addition to reading the magazines, 46 per cent of all the boys and 31 per cent of all the girls read the science articles more often than those devoted to other fields.

Mahoney[24] has recently completed a study of children's questions. She collected 6,561 questions from 2,534 fourth-grade, fifth-grade, and sixth-grade children by an appropriate technique. Her analysis of these questions was very thorough. She secured the kinds of interests and the progression of interests displayed by the children in each grade. In addition, she organized the questions under suitable headings and tabulated the questions and their frequencies. Her conclusions substantiated those of the earlier studies of questions generally. She found

(1) that these children as a whole were more interested in the biological than in the physical sciences, (2) that there was a shift of interest towards the physical sciences and away from the biological sciences from the fourth to the sixth grade, (3) that these children were interested in nature objects, (4) that live animals were most interesting to them, (5) that these children were more interested in animals, plants, and planets in general, than in any specific animal, plant, or planet, (6) that the chief phases of animals and plants, which these children were interested in, were physiology and morphology.

A comparison of this study with that of Palmer is interesting. Palmer found that questions concerning habits, taxonomy, economy, and physiology were the most numerous. This study lists physiology and morphology as the most important aspects of living things with respect to the number of questions asked. Palmer's subjects were rural children. Mahoney's subjects were secured in a fair-sized city. This difference may therefore be the result of the effect of the two environments. There are a number of other studies[25, 26, 27, 28, 29] that might contribute materials for a synthesis of subject-matter in science. These are not reviewed here because the emphasis in this study is on materials primarily appropriate for children.[24]

Summary of studies completed since 1925. The contributions which the investigators claim for these later studies may be summarized as follows:

1. The extended study of children's questions has established the kinds of materials in which children are interested, and the major divisions of the respective sciences in which the interest is most keen. One study lists the specific activities and items under each division of science about which children ask questions.

2. A summary of the practices with respect to grade placement has been made available.

3. A technique involving authoritative source books, children's questions, and the opinions of laymen has been used to secure a list of objectives appropriate to elementary science. The appropriateness of these objectives has been validated by learning studies. The subject-matter items found in research and in typical courses of study in elementary science have been synthesized about these objectives.

4. A technique has been developed for the purpose of obtaining appropriate core and marginal content contributory to the understanding of one illustrative principle of science. This technique applies primarily to teacher-training courses.

5. An analysis has been made of recent courses of study in elementary science which reveals the ideas and principles now utilized in these courses.

6. The concepts possessed by children with respect to simple scientific terms, such as "stone," have been obtained by an appropriate technique.

7. An extensive study of the allusions to science in widely circulated magazines has produced a long list of items suitable for further study.

The trend in these investigations has been away from the further determination of natural science interests and towards the determination of suitable objectives of elementary science instruction. The trend in objectives is away from acquaintance, identification, and appreciation of nature and towards the formulating of major generalizations to which the subject-matter ultimately can contribute.

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A PROJECT IN HEAT

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At the suggestion of friends the following is offered in continuation of a paper on the Project Method in undergraduate physics which was read before the American Association of Physics Teachers and afterwards published.[1]

In the hurried and crowded work in the physics laboratory course as usually given, the student is likely to lose interest in his work and to surrender himself to a monotonous routine of performance, observing strict "economy of thought." If, however, his curiosity happens to become active as he starts a problem of his own choosing his work takes on a different character. He becomes absorbed in his problem and he tries to work it out for himself, taking tactful suggestion gladly but asking for very little detail instruction. He seems to learn more about the general work that is going on, even though he, himself, is withdrawn from it. He takes a sort of proprietary interest in things about the laboratory that stimulates the other students remarkably, and may sometimes be quite amusing.

Project assignments in undergraduate laboratory work in physics should never be made to students who do not show unusual promise; and to those only when they are deeply interested. In order to insure this interest it is safest to assign just what is asked for by the student, guiding him as much as possible in the asking. His curiosity may be aroused in many ways. Sometimes (too often in fact) he starts thinking about things that the laboratory course does not present. An article in a Sunday paper; a visit to an industrial plant; a chance remark overheard in the boarding house, or in rare instances a casual statement made by the professor in the physics lecture, may start his interest.

The problem, if it is successful, will develop the student's interest in what it deals with and in the general work of the laboratory as well. It is a well-known fact that interest in a narrow subject begets interest in the whole field. While spending his whole time on his restricted task the student never falls behind the rest of the class, and his self-assurance develops an interest in physics in his fellows. The tone of the whole class is improved when a few superior students are working intelligently on worth-while problems of their choice. The worker usually carries his assigned project through and then comes up with new ideas on further possibilities. He frequently works on different phases of the problem through several years, and many masters theses originate in the sophomore year by this method.

As an example of a project that worked out well the one outlined below is given.

The writer spent some time one evening with his old books and while going through Ganot he read with passing interest the well-known paragraphs on the ice calorimeter. The next day in a lecture on heat given to a large class of sophomores he remarked that a large block of ice with a cavity melted in it would make as good a calorimeter as almost anything else. (This fact is well known but is sometimes omitted in a crowded course.) A student spoke out in the lecture and showed that he was interested, so the lecturer explained how easy it was to use it in finding specific heat, or in finding the latent heat of fusion of ice. He showed the equation

$$M S t = L_t m$$

and called attention to the fact that there was no "water equivalent" to complicate matters with such a calorimeter.

Three students remained after class and asked permission to try to work out the latent heat of fusion with such a calorimeter, and they were called into conference that

afternoon. They were told to think it over and to look up whatever they could find concerning the work. They were to report several days later for instruction.

After thinking it over carefully and discussing it with the laboratory force it was decided to give these men very little instruction in the matter. So a sheet with a few suggestions on it was drawn up, referring the workers to their lecture notes and telling them certain things to avoid. At the end of such actual instruction as was given, a sentence to the effect that if the student could think of a better method he could use it, was appended.

With this sheet in hand the students started to work. Very soon things began to happen. At first they worked hurriedly, placing the hot metal ball into the hole as quickly as possible. Then one remarked that if the hole were mopped dry and the

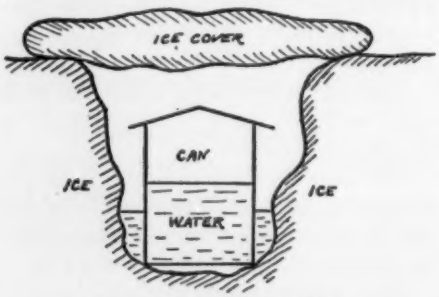

FIGURE 1.—Ice calorimeter.

cover placed over it there would be no need to hurry further, since the cavity would be at 0° C. and no melting would take place. Another found that a dry handkerchief would answer quite as well as a mop for taking the water out of the hole and that since the specific heat of the linen was small, nothing would be gained in a practical way by chilling it beforehand. Many such things were thought out and presented as discoveries.

The results obtained were very close and the students were pleased with themselves and physics in general.

The following is a set of data and results obtained in one determination of the latent heat of fusion of ice:

M = mass of copper ball = 120.8 grams
t = temperature of the ball = 96.5° C.
S = specific heat of copper = .0931
m = weight of melted ice
L_t = Latent heat of fusion of ice

Wt. of cloth + wt. melted ice =	42.22 grams
Wt. dry cloth =	28.50 grams
m = wt. melted ice =	13.72 grams

$$M S t = m L_t$$

$$120.8 \times .0931 \times 96.5 = 13.72 L_t$$

from which

$$L_t = 79.1$$

This simple project, which was suggested by chance and given for only one credit, worked so well on specific heat and latent heat of fusion that the whole class of over one hundred students performed it with good effect, using 1500 pounds of ice in excess of the usual amount.

The originators of this project were used as instructors for the others who performed the experiment, and the general interest in heat was unusually high. It was thought, however, that the work would stop with specific heats and latent heat of fusion and the laboratory teachers turned their attention to other things.

To the surprise of every one, two intelligent students came quietly to the office of the head of the department and asked permission to carry the work further and determine, by the use of the ice calorimeter the latent heat of vaporization of steam. When asked how they expected to proceed they said that they would take a large block of ice and melt a cavity in it and after drying it out carefully they would put a cover of ice over it. Then they proposed to let steam into the cavity and condense it by melting ice, the water of which would collect in the cavity along with the condensed steam.

When asked how they expected to distinguish between the condensed steam and

the melted ice they went away very much confused. A day or two later they came back and said that they proposed to put a copper can with a weighed amount of water in it in the hole and bring it to zero degrees C, drying the cavity carefully after the cooling of the water. They then proposed to pass steam into the water, the can being in the cavity, condensing a weighable amount of steam by melting a weighable amount of ice. In this way they expected to keep the two amounts of water separate and to obtain enough data to make the computation of the latent heat of vaporization of steam possible.

It was suggested to them that the introduction of metal can with water in it might complicate matters and make the consideration of a water equivalent necessary. The students were told that the chief value of the method was simplicity and that if the equations were complicated by a water equivalent all the good from it would be lost; and again they went away.

They came back and one of them stated that if their scheme were used the can and its water would be at zero degrees C in a cavity at zero degrees C at the start of the experiment, and that they would be in the same condition at the end. He reasoned correctly that under these conditions the can and the water in it would behave, as far as heat absorption or emission is concerned, as though they were not there at all. He insisted that equations would not be complicated and that they would like to proceed.

So a can with a cover was made and arranged as in the figure and the experiment was carefully performed with the following results:

Wt. can + water + steam = 85.38 grams
Wt. can + water = 84.60 grams

m = wt. condensed steam = .78 grams

Wt. cloth + melted ice = 20.40 grams
Wt. dry cloth = 15.20 grams

M = wt. melted ice = 5.20 grams

L_v = Latent Heat of Vaporization of steam

$$m L_v = M \times 80$$
$$.78 L_v = 5.20 \times 80$$

from which

$$L_v = 533.3$$

CONCLUSION

The project is illustrative of the several points discussed in the above paper.

(1) It was suggested by chance in a lecture.

(2) Several students were genuinely interested and they arranged the details of the method themselves.

(3) The results were good. Interest was stirred in the workers and in the whole class.

(4) The teaching of the subject of heat was made effective.

(5) The workers were inspired to think ahead and work out their own method for an advanced problem.

(6) They were made to solve their own difficulties and their deduction of the fact that the can would not change the fundamental processes was a good mental exercise.

Many other problems as stimulating have been successfully attempted, but it was thought that an account of this one in the somewhat dry subject of heat would show the possibilities of the project method.

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A GENERAL SCIENCE LESSON

JOSEPH SINGERMAN

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Conscious effort is being made in our actual teaching at James Monroe High School to emphasize desirable attitudes, and to develop in pupils scientific habits of thinking.

Following is a step by step account of a lesson presented to a first term class in General Science as recollected by the teacher at the end of the day. "T" indicates questions and statements made by the teacher. "P" designates statements made by a pupil. No attempt is made to indicate which pupil made each response, but where pupil statements designated by separate P's follow each other, each statement was made by a different pupil.

The lesson was observed by Dr. George C. Wood, chairman of the department. A few remarks made by Dr. Wood during the course of the lesson are included below.

AIM OF THE LESSON

1. To give practice in and encourage scientific thinking.
2. To get the pupils to realize that air has weight, and that it is this property of the air which causes the hydrogen balloon to float.
3. To have the pupils realize that hydrogen is matter, and that it is lighter than air.

After a review of the previous day's work and of the assignment for the day, the lesson proceeded as follows:

T I shall perform an experiment. (Teacher begins to arrange apparatus.) *Chairman* (to class): What method of the scientist is Mr. Singerman about to use?

P Experiment.

T How many of you have heard of hydrogen gas before? (Writes "hydrogen" on board.)

Several hands go up. Teacher calls on one.

P Hydrogen is used in dirigibles.

T We shall learn something about the air around us, and the method will be a very interesting one. You will have many opportunities to do some good scientific thinking. I am going to experiment with hydrogen gas. You may think it funny for us to experiment with hydrogen in order to learn something about air; but, if you make careful observations, and do good scientific reasoning, you will find it possible to draw a logical (sensible) conclusion about the air around us.

For the time being, I don't want you to pay too much attention to this part of the apparatus except that I want you to know that I am making hydrogen gas. If some of you are curious: I have some zinc metal in this bottle, and shall add to it a very strong acid, sulphuric acid. You can see the bubble of hydrogen coming off.

Chairman (to class): What kind of energy is represented there?

P Kinetic.

Chairman: Yes, that too. And what other kind?

P Chemical.

Chairman: That's right.

T What is coming out of this tube? (Pointing to end of delivery tube.)

P Hydrogen.

Teacher affixes toy balloon to end of delivery tube.

Class shows evidence of delight in watching the balloon swell up.

T You are making an observation. What is it?

P The balloon is bulging.

T Keep this in mind. The observation is the key to the solution of a scientific

problem. What conclusion can you draw from the observation, in regard to hydrogen?

P The balloon is to rise.

P Hydrogen is lighter than air.

P Hydrogen occupies space.

Teacher writes on board, before commenting:

hydrogen
1. going to rise
2. lighter than air.
3. occupies space.

T Three possible conclusions are suggested. We must not be hasty. Let us consider one at a time, and see if it is based on the evidence—the observation. What *is* the evidence? Let us be clear on that point.

P The ballon was bulged by the hydrogen.

T Yes. Now, who concludes that the balloon is going to rise?

Much evidence of enthusiasm among the students. They seem to be ready to argue.

P If you tie up the balloon and take it off, it will rise up.

P Yes, it's lighter than air.

(One or two pupils, obviously, were familiar with this property of hydrogen, but not so far the class as a whole.)

T Now be careful. Are you telling me what to do, or are you drawing a conclusion based on the evidence? Remember, what *is* the evidence?

P The balloon blew up.

P That just shows that hydrogen takes up space. That doesn't tell us anything about the weight.

P (Pupil who offered conclusions No. 1) That's right; hydrogen occupies space.

T I am glad you listened to reason. The real scientist is always ready to change his opinion, provided the evidence shows he is wrong. You have the scientific attitude.

T We just learned something about hydrogen. What is it?

P Hydrogen occupies space.

(Teacher crosses out suggested conclusions 1 and 2 on board.)

T Knowing that hydrogen occupies space, what else can we say about hydrogen?

P Hydrogen has weight.

P Hydrogen is matter.

Teacher writes these on the board below the word "hydrogen" previously written.

T Why do you feel justified in drawing these conclusions about hydrogen?

P We learned that anything that occupies space is matter, and all matter has weight.

T Fine. That is good scientific thinking. You've made use of facts already learned in analyzing a new problem. The balloon, which had been expanding all the time, was now removed and tied up with thread.

T We say that hydrogen has weight. What *is* weight?

P The pull of gravity.

T What is gravity?

P The force which pulls objects toward the center of the earth.

T Then gravity is pulling this balloon down. Right?

P Yes.

T Just as it pulls this chalk. That is what makes things fall.

Teacher drops chalk a few times in succession.

T Gravity is pulling the balloon down. Right?

P Yes.

Teacher releases the balloon.

T It falls up.

The class was evidently much enthused over the situation. (Maybe some one noticed that the teacher heaved a sigh of relief—the launching of the balloon was successful.)

T This confronts us with a new problem. Now, here is the situation. We all agreed that the balloon has weight, same as the chalk, the bottle, *et cetera*. But, instead of falling down, it went up.

P Magic.

T The scientist considers that every happening has a cause. There is no magic. Something *caused* the balloon to go up.

P The balloon is lighter than air.
P Maybe hydrogen overcomes gravity.
T That would be the same as saying that it has no weight. Let us analyze the problem. This chalk has weight. Which way will it go? (Holding chalk in hand.)
P Down.
Teacher *raises* the chalk, meanwhile chuckling at the situation.
P Something pushes the balloon up.
T That sounds reasonable. What *can* be pushing it up?
P The air.
P Maybe the hydrogen is pulling itself up.
T Trying pulling *yourself* up.
P I'm not hydrogen.
T Get hold of your belt, and pull yourself up. (Pupil obviously realized he was corrected.) Try some other way. You have to push on something else—the desk. You cannot pull yourself up. Neither can the hydrogen. Gravity is pulling down, something is pushing up. *That* sounds reasonable.
P The air.
T What makes you think the air is pushing it up?
P Hydrogen must be lighter than air.
T What did you just learn about air?
P Air is heavier. Air has weight.
T Right (writing on the board, and underlining, "air has weight"). Here you see how, by experimenting with hydrogen, and by scientfic reasoning, we learned something about air. Now who will volunteer to tell briefly the evidence and the line of reasoning involved?
Pupil began explanation, but bell rang before she finished. Below is indicated the manner in which the lesson ended in another class which met on the same day.
P You mixed zinc in the bottle with ether.
T Sulphuric acid.
P With sulphuric acid, and hydrogen came off. Then you connected the balloon and we saw the balloon blow up. This showed that hydrogen takes up space. And then you tied the balloon. Then the balloon went up because of its being lighter than air.
T You just told us something about the air.
P Air has weight.
T On what grounds did we conclude that hydrogen has weight?
P Hydrogen occupied space in the balloon, and anything that occupies space is matter, and matter has weight.

Teacher's note:

There was a conscious effort on the part of the teacher, throughout the lesson, to emphasize scientific thinking. Definite effort was made, in addition, to make the pupils conscious of that aim. Where there was difference of opinion, judgment was suspended, pending examination of several suggested opinions. There was practice in cause and effect. Open-mindedness was encouraged when the teacher praised the pupil for his readiness to change his opinion when the facts presented justified the change.

To teach the class the fact that air has weight the teacher mapped for himself a circuitous course which necessitated careful planning, and which gave promise of many pitfalls along the way. Yet he feels that he was justified. It is like the hiker who chooses to walk for many miles when he could ride, or ploughs his way through the forest when he could follow the smooth road; or like the artist who goes to great pains to paint a scene when he could snap it with his camera. The possible by-products of this lesson, that is, the stimulation of interest and encouragement and guidance in desirable habits of thinking, more important than the subject-matter itself, justify the effort expended.

AN ECONOMY PHASE OF EDUCATION

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Educational efficiency today faces an acid test. Conditions of economic stress have necessitated the curtailment of many of the quantity items used in the classroom. The writer chooses to select as an example one item that he believes can be conserved. It is not a frill item; it is one that is used in many ways during the school year. By a detailed presentation of a single phase of a single question it is not hoped to solve immediately all the existing problems of educational efficiency in the use of supplies. However, if one item in a single phase can be used in a more economical and efficient fashion, then perhaps it will follow that other items can be treated in a similar fashion.

The situation. The writer, in a regular classroom situation, constructed and used two types of objective tests. The detail pertaining to the orthodox type of objective test is hereinafter referred to as method one. The detail concerning the type of objective test developed by the writer is referred to as method two. The writer believes that the procedure evolved from the following set-up is educationally economical and efficient. In verification of this belief certain substantiations are given. Possibly the writer is wrong. Therein certainly exists the possibility for discussion. With this situation in mind, the relative merits of two methods of answer indication for identical test material are herewith set forth.

Material used. The test material in the problem example at hand covers a unit of work in general science. The test consists of eighty items arranged in four sections; true false, multiple choice, completion, and picture recognition. The writer constructed the test after the fashion described under method one and then revised the test as described under method two.

Test construction—method one. The initial construction of the test was after the orthodox fashion. Space was provided on the test itself for the answers. The twenty true false questions, with space left for the answers, took two mimeographed sheets of paper. The multiple choice questions took two sheets with provision thereon for the answer. The completion also took two sheets of paper. The picture recognition took three sheets of paper with answer space. Later the second question was revised so as to take only one sheet. The final total number of sheets used, therefore, was eight.

Test construction—method two. The revision of the test retained the exact statement of the items and, in fact, the test remained intact as in method one except for the provision for answers. As a result of the fact that space was not provided on the test for the answers, the final total number of sheets used was six.

Answer provision in method two. The answer spaces for the test form described in method two were placed on an answer sheet. The sheet was divided into four sections to correspond to the sections of the test. (See Figure 1.) The test question was read by the student and the answer placed on the answer sheet in the corresponding section opposite the same numbered item. Any skill necessary for the student to make the answer complete was developed by a practice test previous to administering the real test. No written material was placed by the students on the sheets containing the statements of the test. These test sheets were bound in a separate folder for each test and filed for future use.

Administering the tests. In the administration of the tests used in method one, the regular routine of objective testing was followed. With method two, however, each

Name .....Grade.....Period .....Room .....

(Last Name) First Name) PRINT NAME IN CAPITAL LETTERS

Instructor ..... Unit..... Date .....

GENERAL SCIENCE UNIT SUMMARY ANSWER SHEET

Note: Follow the directions as given at the beginning of each section of the unit summary test.

Section 1.	Section 2.	Section 3.	Section 4.
1.....T.....F.	1.....a.....b.....c.....d	1.....	1.....a.....b.....c.....d
2.....T.....F.	2.....a.....b.....c.....d	2.....	2.....a.....b.....c.....d
3.....T.....F.	3.....a.....b.....c.....d	3.....	3.....a.....b.....c.....d
19.....T.....F.	19.....a.....b.....c.....d	19.....	19.....a.....b.....c.....d
20.....T.....F.	20.....a.....b.....c.....d	20.....	20.....a.....b.....c.....d
Score .....Score		Score .....Score	
			Total Score .....

FIGURE 1. Answer Sheet.

Section 1

Directions: Answer the following True-False statements by placing an "X" in the space before the T if the statement is true or in the space before the F if the statement is false. Place answers on the answer sheet. Do not guess.

1. In pasteurizing milk, the milk is heated to about 140 degrees Centigrade. (Other items follow through to twenty.)

Section 2

Directions: Complete the following multiple choice statements by placing an "X" in the space before the letter on the answer sheet indicating the correct word or words.

1. An epidemic is the (a) cure for diptheria (b) wide spreading of a disease (c) resistance of the body to disease (4) coccus form of bacteria.
(Other items follow through to twenty)

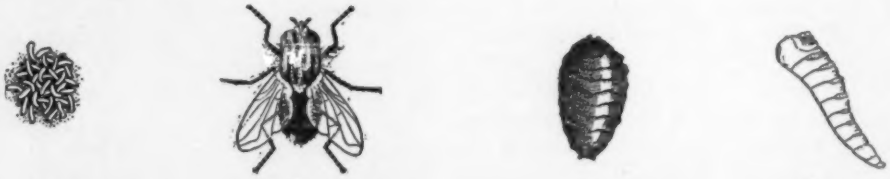
Section 3

Directions: Complete the following incomplete statements by placing the correct word or words in the space provided on the answer sheet.

1. Poisons produced by germs which invade the body are called—
(Other items follow through to twenty)

Section 4

Directions: There are several incomplete statements about each of the following figures and diagrams. Complete each statement by placing an "X" in the space before the letter on the answer sheet indicating the correct answer.



a b c d

In the above figures showing the life stages of the fly:

1. The pupa is represented by the letter—
2. The eggs are represented by the letter—
3. The larva is represented by the letter—
4. The adult is represented by the letter—
(Other items follow through to twenty)

FIGURE 2. Samplings of Typical Four Form Test Used With The Answer Sheet Device.

student was given an answer sheet. (See Figure 1.) The folders, each of which contained a test, was then passed to the students. The answers were given by following the directions shown in the sample test in Figure 2.

Correcting the tests. The correction of the tests used in method one was laborious despite the utilization of the various objective techniques. In correcting the method two tests, a technique was used that differs from standard practice sufficiently for description. At the time the answer sheets were mimeographed, special durable paper copies were also run through. Sections 1, 2 and 4 (see Figure 1 of this answer sheet) were cut out so as to form windows. These windows revealed the correct answer space when the stencil was superimposed over the answer sheet of the student. For Section 3 the answer stencil was cut at the top, bottom and right sides of the section. Thus a flap swung as on a hinge at the left of the section. On the back of this flap the correct answers for the completion spaces of Section 3 were placed. Thus the key and the student's answers appeared side by side when the stencil was placed in the correcting positon. As is shown in Table 1, the correction time taken for the tests used in method one greatly exceeded the time used in the correction of the tests used in method two.

Filing the tests. The relative efficiency of the two methods can well be compared in the filing. With method one the file containing the tests soon attained a considerable bulk with a resultant difficulty of ready reference. (See Table II.) File space is ever at a premium. The single answer sheet of method two filed easily, was convenient for reference purposes and made possible the convenient compilation of data over a period of time. The tests themselves were returned unmarked by the students, counted, inspected and filed for use in subsequent classes. For these sampled reasons the merit of method two gained again over that of method one.

Advantages discussed. Method two stands out best in comparison with method one when viewed in the light of the simple presentation of numerical facts. Tables I and II present this comparison as briefly as possible and yet give a two-year picture. The writer assumes that a good teacher-made test is usable for several semesters before any revision is necessary, provided the test is properly protected against coaching on subsequent administration. Possibly such revision would be necessary before that time, possibly revision would not be necessary even then. However, a typical time of two years is used.

Table I.
Comparison of Time Used in Construction and Correction of Tests

	Method 1	*Method 2*
Time used in construction	¼ more (2 pages)	¼ less (2 pages)
Time used in correction	5 minutes (average for each test)	1 minute (average for each test)
Time in two years correction	40,000 minutes	8,000 minutes
Time saved		32,000 minutes

The point has been mentioned to the writer that with method one the tests can be returned to the students and used as the basis for remedial teaching. This is a desirable procedure providing the tests do not remain in the possession of the students. If the students possess old tests, any subsequent administering of the same tests, or even of newly constructed tests, will lack objectivity. However, for remedial teaching, method two allows the use of the test folders and the corrected answer sheets if desired. Further, the construction of error

analysis charts for objective remedial teaching is greatly simplified by the ease of data compilation from the answer sheets of method two. Other points have been mentioned to the writer which purport to show wherein method one has advantages which are not possible with method two. So far it has been possible to meet such challenges.

Summary and conclusions. The writer believes that method two is superior to method one in many ways. A distinct savings is evident in the materials for the initial construction and this savings is increased with each subsequent use of the tests. The savings in time, both in construction and correction of the tests, is a factor that can well be appreciated by any teacher who constructs and uses the objective type test. (See Table I.) The convenience of filing is an aid to the keeping of efficient records. Relevant factors almost without end could be added to this list. The total conclusion would still be, however, that time, money and energy are saved, efficiency is increased, all the advantages of the orthodox type of objective testing are retained and new advantages constantly evidence themselves with the continued use of the method two tests.

TABLE II
COMPARISON OF COSTS OF PAPER USED BY TWO METHODS

Method—Material		
Each test	8	pages
Number of students in each department	500	
Total number pages used each test	4000	pages
Total number pages used for four tests	16000	"
Total number pages used in one year (eight tests)	32000	"
Total number pages used in two years (sixteen tests)	64000	"
One ream of paper	500	sheets
64000 sheets	128	reams
Cost of one ream (variable)	.50	
Cost of 128 reams	$32.00	
Cost for two years	$64.00	
Each test	6	pages
Number of students in department	500	
Total number of pages used each test	3000	pages
Total number pages used for four tests	12000	"
Total number pages used in one year (eight tests)	12000	
Plus pages used for answer sheets in one year	4000	"
Grand total for one year	16000	"
Total cost for paper two years	$20.00	
Total savings over method number one in two years	$44.00	

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PHYSIOLOGICAL FOOTBALL

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How to interest students of high-school age in the more ordinary and less spectacular aspects of any subject is always a problem. Many instructors doubtless will agree that the task of keeping the class work always fresh and interesting is a constant challenge to both skill and ingenuity. The device explained in the following paragraphs possesses the advantage of novelty. It is based upon the premise that all boys—and many girls—are interested in sports, and especially in football. "Physiological Football" links the classroom work with the predominating outside interest of most students —athletics.

The chemistry of digestion usually presents problems to the teacher and difficulties for the pupils. Considerable ingenuity is required in planning the necessary drill exercises, if the interest of the good student is to be maintained while that of the poor scholar is also increased. "Physiological Football" was invented to provide a drill type lesson which would also increase the factor of interest. It has proven successful in teaching physiology to students of high-schools age."

The basic idea of this game is to adapt the usual scrimmage diagram as featured by football coaches in their "chalk talks" to the teaching of the digestive enzymes. With the blackboard blank, the instructor first arouses interest by asking the members of the class if they are proficient at solving riddles, and whether they understand football so that they can solve a football riddle. The novelty of this approach is frequently sufficient to arouse even the most uninterested student, usualy the big husky boy whose enthusiasm for things physiological is woefully lacking.

"Since you are all expert at solving riddles and also familiar with football, tell me: Why are the digestive enzymes like a football team? And why is each enzyme, considered separately, like an individual player?" The answer to the first is that there are eleven enzymes and eleven players, and that both players and enzymes are comparable in that they work together to achieve a common purpose. The answer to the second riddle is that each has a specific duty to perform. Each enzyme has a specific class of food on which it acts, just as each player has a certain opposing player to act on, or, as it is termed in football, to "take out" of the play. It may also be suggested that some enzymes only begin the process of digestion, leaving the final stages to other enzymes which are found further along the digestive tract. Such enzymes may be likened to the player who breaks up the opponent's "interference," leaving the actual tackling to another member of the team. While this is a good solution, and others equally appropriate may be suggested by a wide-awake class of football enthusiasts, the correct answer is the one previously indicated.

Having thus set the stage, the usual "scrimmage" line-up is diagrammed on the board and copied on suitable paper by each student. The names of the players are omitted. One team may represent the school and the other their great rival; or preferably, one team may be the Enzymes and the other the Acton (act on) team, representing, in this case, the foods which are "acted on."

The class now names the various players, placing the foodstuffs on one team, (the defense) and the enzymes on the other. Lines are then drawn to indicate the enzyme which acts on each food, *i.e.*,"takes out" of the play. From five to ten minutes should be allowed for this exercise. The instructor may precede this part of the game by a stirring word

picture of a thrilling football situation to arouse further interest should such a procedure be considered desirable.

After the class has become familiar with the use of the diagrams to represent enzyme action, variations may be introduced. For instance, the foods may be placed in different relative positions on the team, or to use a football term, the "line-up" may be changed. "Fats" may be moved from Guard to Center and "Milk" from Tackle to Halfback, etc. Other possible modifications include an unbalanced line, double wing back, forward pass formation and other changes of similar character. Still further variation may be introduced by labeling only part of one team, leaving the class to complete the diagram. The teacher who is familiar with football will doubtless introduce many other variations to the central idea.

By using a suitable method of scoring it is possible for the teacher to "play" the entire class at one time or to have different individuals or groups play with each other. A simple method of scoring allows ten points for a perfect paper with a deduction of one point for each error made by the student. The opponent's score increases at the same rate at which the student's score decreases, as indicated in the abbreviated accompany-

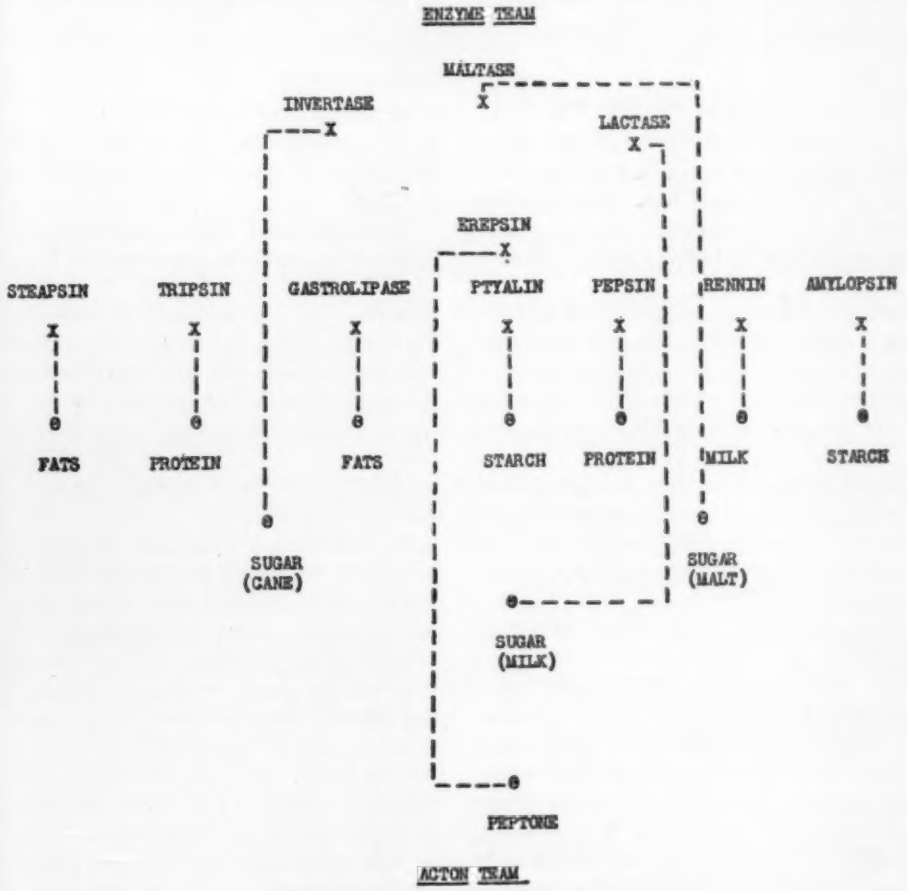

FIGURE 1.—The Lineup of the Teams.

ing table. If the class is unusually bright it may be found desirable to deduct two points for each error and at the same time to give proportional credit to the mythical opponents.

This method of conducting a drill exercise, arouses considerable interest but is not without some accompanying disadvantages: (a) It is not as successful with girls as with boys, (b) It may be permitted to consume too much time, (c) It requires a teacher who knows the essentials of football.

HOW SHALL SCIENCE INSTRUCTION BE ORGANIZED?*

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Early in the fall of 1933 a list of criteria for selecting and organizing subject-matter in elementary and high school science courses was prepared. This was based largely on the *"Thirty-First Year Book of the National Society for the Study of Education"*; and on Downing's *"Teaching Science in the School."* It included, in addition, some other statements which seemed pertinent. This list of 29 "yes-no" statements was submitted to about 25 science teachers. The replies of 12 who may be classed as quite expert in the field of science teaching were tabulated. These reactions indicated certain desirable changes. The ensuing revision resulted in a form making distinctions among *criteria, plans,* and *features* of organization in science below the college level, with judgments of each concept to be expressed on a scale from 0 to 7. As organization involves selection, it was decided to omit all reference to selection in order to simplify the points at issue. Each point on the scale was defined by means of the designations: very great (7), great (6), considerable (5), some (4), little (3), very little (2), and no (1) to be applied to (1) the importance of *criteria,* and (2) the desirability of *plans* and *features,* respectively. While it was understood that there might be omission of certain desirable criteria, plans, or features, the possibilities for low or high ratings on those listed gave promise of value to be derived from the submission of the lists to experts in science teaching.

Accordingly, one hundred and fifty copies were sent out—fifty to members of the N. A. R. S. T., fifty to members of the Central Association of Science and Mathematics Teachers, and fifty to teachers in colleges, normal schools, and departments of education in universities. From these, by January 1st, twenty-one responses were received from the N. A. R. S. T. group, twenty-four from the C. A. S. M. T. group, and twenty-one from the college group. Those which were received later were used in the computation of the final consistency correlation and for other computations to which reference is made in succeeding paragraphs.

The first set of tables prepared gave the mean rating on each criterion, each plan, and each feature, for the three groups mentioned, and for the total number of sixty-six in these groups. In addition, standard deviations, coefficients of variability, and standard errors of the means were computed for each group, and the items were ranked. Thus each criterion received a rank from 1 to 20 in each of the four groups, there being twenty criteria stated; each plan a rank from 1 to 5 among the five plans; and each feature a rank from 1 to 8 among the eight features. These ranks were based on the mean judgments on the seven-point scale. In case mean ratings were the same for two or more items, the one having the lowest variability rating was ranked highest. Table I gives

* Given as an interpretation of the work of a Committee of the National Association for Research in Science Teaching by the Chairman at the annual meeting in Cleveland, February 26, 1934.

the items arranged in order of rank in the total group of sixty-six. At the right of each item is the rank in agreement of the judges. Note that this is the inverse order of the coefficients of variability. The less variable item shows the highest degree of agreement.

TABLE I

CRITERIA, PLANS AND FEATURES OF ORGANIZATION OF INSTRUCTION IN SCIENCE

I

The criteria below are given in the rank order of the mean judgments of sixty-six experts in science teaching.

Rank	*Mean Rating*	*Item*	*Science course should be organized:*	*Rank in agreement by judges*
1	6.20	2 l	to explain some scientific attitudes and show how they affect man's thinking (*e.g.*, open-mindedness, suspended judgment, etc.)	1
2	6.05	2 m	to explain the methods of science and show how they operate in every-day affairs (*e.g.*, how problems are solved).	2
3	5.76	2 c	so as to make an immediate and sustained appeal to pupils (interest).	6
4	5.74	2 h	so as to encourage the belief in, and practice of, desirable social ideals involving science (*e.g.*, community coöperation in cleaning up rubbish).	4
5	5.72	2 a	so as to be of the most direct use to pupils in their every-day living (utility).	3
6	5.41	2 fx	to directly explain the local environment of the pupil (*e.g.*, the local electric light plant).	8
7	5.38	2 b	so as to be within the capacities of all pupils enrolled (individual differences).	12
8	5.32	2 d	so as to be within the abilities of all pupils enrolled (individual differences in capacities and former training).	10
9	5.26	2 e	so as to make a direct and immediate contribution to the welfare of our social order (*e.g.*, injurious insects and their eliminations).	17
10	5.17	2 g	so as to stimulate discussions of problems related to science which are prominent in the news of the day (*e.g.*, utilization of water power in the Tennessee River region).	5
11	5.17	2 q	so as to have unity and coherence as a whole.	15
12	5.03	2 k	so as to enable pupils to spend adequate time on desirable hobbies related to science (leisure-time objective).	11
13	5.00	2 n	so as to provide for the exercise of creative imagination.	16
14	4.73	2 j	so as to make direct contributions to wise vocational choice by pupils (vocational objective).	9
15	4.59	2 fy	to explain aspects of the national environment not found locally (*e.g.*, geological formations not found locally).	7
16	4.52	2 i	so as to stimulate in the pupil the sense of his own worthy achievement (for the purpose of preventing inferiority feelings).	14
17	4.28	2 p	to make maximum use of the personal equipment of the teacher in knowledge and training.	18
18	4.15	2 fz	to explain aspects of the world environment not found in the nation (*e.g.*, animals of foreign countries).	13
19	4.08	2 o	to make maximum use of the school's facilities.	20
20	3.65	1	to accord with the organization of the developed sciences, *e.g.*, physics, chemistry, geology, botany, etc.	19

II

The following plans of organization of courses in science in public schools below the college level are arranged in the rank order of the mean judgments of sixty-six experts in science teaching.

Rank	*Mean Rating*	*Item*		*Rank in agreement by judges*
1	5.48	1	A plan using major topics having large social implications and involving the solution of important social problems (*e.g.*, "Our City Water System").	2

2	5.09	2	A plan using comprehensive generalizations of science in the forms stated by men of science most gifted in comprehensive insight in science. (*e.g.*, "The Sun is the Chief Source of Energy for the Earth.")	5
3	5.08	3	A plan using personal individual problems related to science. (*e.g.*, "How I May Choose the Best Diet.")	1
4	4.38	4	A plan using self-initiated individual projects related to science. (*e.g.*, "Building of a Radio Set.")	4
5	4.05	5	A plan using group projects to science. (*e.g.*, "Planning an Auditorium Period.")	3

III

The following are features of organization in science courses in the public school below the college level arranged in the rank order of the mean judgments of sixty-six experts in science teaching.

Rank	*Mean Rating*	*Item*		*Rank in agreement by judges*
1	6.15	2	An in-class program consisting of activities including assignment, study, discussion, reports, drill, recitation, explanation, demonstration, laboratory work, or other activities as will best serve the learning process.	1
2	5.54	6 b	Judgment of out-of-class activities by estimates of specific traits of character evidenced in the out-of-class work. (*e.g.*, initiative, self-liance, systematization, etc.)	2
3	5.53	5	Judgment of in-class achievement from scores on valid, reliable, and comprehensive tests.	3
4	5.15	4	Voluntary, out-of-class activities designed to be a part of the pupils' leisure-time programs. (The purpose is to give the pupils an opportunity to formulate an integrated leisure-time program and to stimulate voluntary work related to science.)	5
5	4.86	6 a	Judgment of out-of-class activities by estimates of value based on concrete results of such activities.	4
6	4.71	1	An in-class program to be used for the definite learning of a carefully selected list of important subject elements in science possible for all pupils enrolled during the time taken for class meetings. (The purpose is to save out-of-class time for individualized activities.)	6
7	4.23	3	The saving of out-of-class time for voluntary individualized activities related to the in-class program. (This implies no assigned lessons (home-work) to use pupils' out-of-class time.)	7
8	2.98	7	A traditional, conventional, academic lesson-giving and lesson-learning plan with home-work of a required kind.	8

Item 2 1, "to explain some scientific attitudes and show how they affect man's thinking" ranks highest in importance among the *criteria*. Its mean rating by the sixty-six experts is 6.20 on the seven-point scale. It also ranks first in agreement of the judges, *i.e.*, there was more unanimity of judgment on this item than on any other criterion in the list. Item 1, "Science courses should follow the organization of the developed sciences, *e.g.*, physics, chemistry, geology, zoölogy, botany, etc.," is the lowest ranking item in importance. Its mean rating is 3.65 on the seven-point scale, which, according to the designations, means that it should be of little importance in the organization of science courses. The rank in agreement is 19, meaning that there was a greater range of judgment on this item than on any other but one. The standard errors of all the means are small, showing that the mean ratings are all highly significant. For example, a critical ratio of three means certainty that the mean is a reliable evaluation. For item 1, the critical ratio is (3.65 ÷ .23 =) 15.9. Other critical ratio testing the significance of the means of the criteria range from 15.7 to 47.7. The last named is for Item 21

referred to as the highest ranking item in importance.

In order to determine the significance of the discrimination shown by the sixty-six judgments of the various *criteria*, differences in mean ratings were found between the first and second, first and third, first and fourth, and so on. These differences were divided by their standard errors. A ratio of 3 was considered significant to indicate certainty of a true difference. In this way, it was discovered that there existed a clear discrimination between the first and sixth ranking *criteria*; between the sixth and fifteenth; and between the fifteenth and twentieth. Items ranking from 1 to 5, inclusive, may then be considered as a group of one general degree of importance; items ranking 6 to 14, inclusive, a second group of somewhat less importance; items ranking 15 to 19, inclusive, a third group of still less importance; and item ranking 20 that of least importance. It should be noted that all but one item has a rating equal to or greater than 4.00 in the total group. This implies that every criterion except Number 1 is of some importance in the organization of science instruction when judged by groups of experts like those used. If we consider the separate groups of judges, Item 2 o has a rating of but 3.80 by the N.A.R.S.T. group. This is the item referring to making maximum use of the school's facilities. This has a rating of only 3.95 among the college teachers, and a rating of but 4.08 in the total group of sixty-six. Among the college teachers, Items 2 fy, 2 fz, and 2 p in addition, have ratings of less than 4.00. Item 1 is the only one rating below 4.00 in every group. The C.A.S.M.T. group rates only Item 1 below 4.00.

No claim is made in this study that there may not be other *criteria*, not included in the list, that may be more important than those listed. The data are valid only within the conditions under which they were obtained. It is claimed that, under similar conditions, the same treatment would yield similar results. This is made evident from the comparisons of rankings in the three separate groups mentioned. Table II gives the rankings of the twenty items in the three groups, and in a still larger group of ninety including judgments received by the Committee at a later date.

TABLE II

RANKS OF TWENTY ITEMS ON CRITERIA OF ORGANIZATION OF INSTRUCTION IN SCIENCE BELOW THE COLLEGE LEVEL

Items	*I* N.A.R.S.T. (21)	*II* C.A.S.M.T. (24)	*III* College Teachers (21)	*IV* Total (66)	*V* Group of (90)
1	20	20	19	20	20
2a	7	4	3	5	4
2b	4	12	14	7	10
2c	3	5	5	3	3
2d	6	14	7	8	7
2e	10	7	8	9	8
2fx	8	9	2	6	6
2fy ...	11	15	17	15	15
2fz ...	16	19	20	18	18
2g	12	6	10	10	11
2h	5	3	6	4	5
2i	15	17	15	16	16
2j	17	13	12	14	14
2k	13	10	11	12	13
2l	1	1	1	1	1
2m	2	2	4	2	2
2n	9	11	13	13	12
2o	19	18	16	19	19
2p	18	16	18	17	17
2q	14	8	9	11	9

Correlation coefficients to express the degree of similarity between groups for the *criteria* are: Groups I and II .78 ± .07; Groups I and III .76 ± .06; Groups II and III .92 ± .03.

Another method of comparison among the three different groups of judges is that of finding the critical ratios for differences between mean ratings of contrasted groups I and II, and I and III, and II and III, respectively, for each item in the list. (A critical ratio of 3.00 or above indicates a significant difference between judgments of the group ratings compared. Of sixty critical ratios, but three were significant. These

were for Item 2 b (Groups I and III); Item 2 fy (Groups I and III); and Item 2 d (Groups I and II). This shows marked agreement among the groups.

Referring to the five plans listed, they rank from 1 to 5 in the order given in the questionnaire (see Table I), considering the total group of sixty-six judges. The only group differing from this order is the group of college teachers. Instead of ranking them in 1, 2, 3, 4, 5, order as listed, this group ranked them 1, 4, 2, 5, 3 in the list as given.

A comparison of critical ratios of differences between the mean ratings of Groups I and II, I and III, II and III, for each of the five plans, respectively, shows only two significant ratios out of fifteen computed. Both are on Plan 2 between Groups I and III, and II and III, respectively. The college teachers rank Plan 2 low (rank 4) which accounts for the divergence.

When differences in the means of the sixty-six total group ratings on the different plans are tested for significance, the first plan is rated significantly higher than the fourth, but not significantly higher than the second or third. It should be noted that each plan, with the exception of Number 4, has a rating of more than 4.00 in every group, showing that it is considered of some importance. Plan 4 is rated 3.95 by the group of college teachers. It has a rating of 4.38 in the total group of sixty-six, however.

Table III gives the rank order of the eight features of organization by the same groups as are represented in Table II.

A comparison of critical ratios of differences between the mean ratings of the groups I and II, I and III, and II and III, for each of the features, respectively, shows no significant differences between the groups. This shows substantial agreement in the ratings of the items. Feature Number 7 has low ratings in all groups (I 3.87, II 2.92, III 3.00, IV 2.98 and V 2.78). This is the feature referring to the use of a traditional, conventional, lesson-giving and lesson-learning plan with home work of a required kind. All groups are agreed that this should be superseded by better features. This is the only feature condemned by all groups. Feature Number 3 is rated 3.76 by the group of college teachers, the only other rating below 4.00. As a group, the college teachers do not think that all out-of-class time should be reserved for voluntary, individualized activities.

TABLE III

RANKS OF EIGHT ITEMS ON FEATURES OF ORGANIZATION OF INSTRUCTION IN SCIENCE BELOW THE COLLEGE LEVEL

Items	*I* N.A.R.S.T. (21)	*II* C.A.S.M.T. (24)	*III* College Teachers (21)	*IV* Total (66)	*V* Group of (90)
1	5	5	6	6	5
2	1	1	1	1	1
3	7	7	7	7	7
4	3	4	5	4	4
5	2	2	3	3	2
6a	6	6	4	5	6
6b	4	3	2	2	3
7	8	8	8	8	8

Considering the group of sixty-six judgments, there is a significant difference between the means for items ranking first and second; also between items ranking second and fifth; and between items ranking fifth and eighth.

In order to estimate the agreement of the three groups of judges on all of the thirty-three items included in criteria, plans, and features, three correlation coefficients were computed—that between mean ratings by the N.A.R.S.T. group and C.A.S.M.T. group is $.88 \pm .03$; the N.A.R.S.T. group and the college teachers $.80 \pm .04$; and the C.A.S.M.T. group and college teachers $.83 \pm .03$. In order to get larger groups to compare, ratings were placed in two sets, each set including one-half from each group. Judgments from additional questionnaires received after January 1st, were apportioned to the two groups thus obtained

so that there were thirty-nine in one group and thirty-seven in the other. The coefficient of correlation between the mean ratings of these two groups for the respective items is .96 ± .02. This is further evidence of agreement between the judgments of groups selected as were these. (A later similar correlation with 45 represented in each group gave a coefficient of .986 ± .01).

Considering all data, there is evident a general consensus of opinion on criteria, plans, and features for the organization of instruction in science courses below the college level. This does not mean that all individuals agree with the consensus—only that a group including from 35 to 45 will agree with another equal group selected in the same manner. In the words of a recent educational writer, ". . . it is important to try to get together on what we shall call important. . . . We must . . . work at the making of consensus." This writer believes that the most vital need in education today is agreement. Disagreement results in meagre accomplishment, for it prevents cooperative action.

In view of the discovered consensus,* the Committee recommends that steps be taken next year to develop further the implications of the findings. As an organization, we can work to great advantage if we will only work together. The consensus seems clearly in favor of instructional organization which departs quite sharply from the traditional specialized science organizations. Scientific attitudes, the scientific method, pupil interest, the practice of desirable social ideals, and everyday life utility, are highly important objectives of organization in the minds of great numbers of experts in science teaching.

The first plan of organization about major topics having large social implications, is consistently favored above the other mentioned with a statistically significant difference between it and the fourth in the list which refers to self-initiated individual projects as the basis of organization.

The feature referring to an in-class program of assignment, study, discussion, reports, drill, recitation, explanation, demonstration, laboratory work, and the like, is rated highest in desirability. This calls for a greater portion of lesson preparation in the classroom. The traditional, conventional, academic lesson-giving and lesson-learning scheme requiring home-work rates very low.

Some of the indicated pertinent questions which we need to answer may be listed as follows:

1. How may we organize instruction (a) to develop scientific attitudes, (b) to teach the scientific method of solving problems, (c) to arouse and maintain pupil interest, (d) to bring about the practice of desirable social ideals, and (e) help pupils most in their everyday living?

2. How may we organize instruction to accomplish the other purposes implied in the other items in the list of criteria? (They are important if perhaps less so than those mentioned in (1).

3. How may we accelerate the movement away from conventional and traditional specialized subject arrangement which is judged of little importance by all groups?

4. What major topics may serve as centers of subject organization in the various grades of the public-school system?

5. What comprehensive generalizations in science are of most use in the accomplishment of the aims implied in (1) and (2)?

6. What are the individual problems related to science which we may use as occasional centers of organization?

7. To what extent should self-initiated individual projects be provided for in science instruction?

8. How may group projects related to science be utilized in science instruction?

9. How may the time element in instruction be so regulated that voluntary activities relating to science shall be made possible

* Later rankings and computations for significant differences among items for ninety judges are in substantial agreement with those for the sixty-six judges.

and integrated with pupils' leisure-time programs?

10. How may we construct valid, reliable, and comprehensive tests to measure all the outcomes of instruction in the various courses in the field of science?

11. In what manner shall we use trait ratings in science instruction?

12. How may we eliminate the traditional, conventional, academic lesson-giving and lesson-learning plan with its overload of required home-work?

RESEARCH STUDIES RELATING TO THE TEACHING OF SCIENCE

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The present bibliography is a supplement to the previous list and covers the period from January, 1933, to December, 1933, inclusive. The arrangement of the bibliography follows the general plan used in the earlier compilation of titles, and presented in outline in the October, 1931, issue of the journal. It should be understood that the arrangement is an arbitrary one, prepared for use in the compiler's course entitled "Investigations in the Teaching of Science."

It was thought worth while to present in Sections A, B, and C of the bibliography certain general references which have been found to be of value to those interested in research in this field. However, it should be clear that no attempt has been made to list there the numerous books, monographs and articles, published during the period, and related to the problems of educational research in general.

The reader will observe that some studies under section D are not specific to the field of science education. All studies, however, are related to the teaching of science and throw direct light on the problems of science teaching. It will also be observed by some readers that certain studies which seem to be of little importance are included. It may be that such studies will suggest further research of great value and it is even possible that, in the light of future research, they may prove to be very significant *per se*.

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11. *Education, Demand and Supply of Teachers of Science*

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12. *Supervision and Administration of Science Instruction*

13. *The Teaching of Science in Foreign Schools*

Turner, F. W. "English Science Teachers." *Science Education* 17:125–127; April, 1933.

Abstracts

GENERAL EDUCATION

HART, FRANK W., *Chairman*. "The New Deal in Secondary Education." *California Quarterly of Secondary Education* 7:331–336; June, 1933.

Professor Hart begins with this thesis, "Regardless of the multitude of contributing causes, there is no escaping the fact that at bottom our present predicament, with all its unhappy consequences, is chargeable directly to the failure of the timber in ethical character and citizenship of our people—to selfishness, to greed, to lawlessness on the part of some of us, and to a low level of political intelligence on the part of the rest of us." He then expands and develops this thesis under these heads: (1) The level of political intelligence is established in secondary schools; (2) The social sciences are zones of neglect; (3) The greatest responsibility of secondary schools; (4) Demand for fearless instruction in economic issues of contemporary life; (5) New lines of attack in secondary education; and (6) The redirection of teaching. —F.D.C.

WEERSING, FREDERICK J. "A Tentative Plan for Reorganization of Secondary School Curricula." *California Quarterly of Secondary Education* 9:157–166; January, 1934.

This timely discussion is presented in considerable detail under these headings: (1) Purpose of the plan; (2) Proposed instructional organization; (3) Curriculum guidance for pupils; (4) The administration of credit; (5) Reorganization of courses of study and teaching procedures.
—F.D.C.

SATTLER, LILLIAN. "Trends in Professionalization in Colleges." *The Junior College Journal* 4:134–138; December, 1933.

A study of 221 catalogues representing "typical American liberal arts colleges" in 40 states was made for the purpose of discovering (1) the nature and extent of combination curricula such as arts-engineering, arts-medicine, etc.; (2) arrangements to give Bachelor's degrees when later portions of the four-year period are spent in professional or technical schools elsewhere; (3) pre-professional curricula without announced affiliation; (4) four-year professional curricula; (5) professional names in titles of departments; (6) professional courses in departments bearing liberal arts titles; (7) recognition without substantial accommodation, and (8) special accommodations. The study presents data indicating a growing tendency toward "these accommodations which American liberal arts colleges are making to the trend toward occupationalization"; the author interprets her findings as indicating that "for many students the four-year liberal arts college must function as a junior college . . . and for others it must serve as a junior college plus a partial or complete professional training."
—F.D.C.

INSKEEP, ANNIE DOLMAN. "Adapting Modern Teaching Procedures to the Dull or the Mentally Deficient Child." *California Quarterly of Secondary Education* 7:357–363; June, 1933.

The author begins this practical article by delimiting her subject to discuss the problem only with relation to "schoolable defectives," who are "the 15 to 20 per cent of the dull and retarded who are in Z sections, limited classes, or scattered around in classes with normal children." She then develops her discussion under these heads: (1) How the mentally deficient differs from the normal child; (2) School needs of the mentally retarded; (3) Pedagogical aspects of teaching the mentally deficient; (4) The program; (5) Subject-matter; (6) Social studies; (7) Factitive and directional reading; (8) The teacher of dull and retarded children. —F.D.C.

GRAVES, MARION COATES. "After Junior College—What?" *The Junior College Journal* 4:111–115; December, 1933.

This article explains an experiment for the purpose of providing for "girls who had graduated from a junior college in good standing, and who were seriously interested in adult problems." The goals of the experiment were to equip the student for the personal and vocational needs later to be met and to give a "greater measure of social intelligence with which to interpret the problems of the communities in which they [the students] expect to live." The curricula followed by these students in pursuit of these goals is described in considerable detail as are also some of the more important outcomes. —F.D.C.

JOHNSON, PALMER O. "The Measurement of Outcomes of Instruction Other than Information."

School Science and Mathematics 34:26–33; January, 1934.

Professor Johnson describes the measurement program which is now being carried out in the Junior College of the University of Minnesota for the purpose of devising for the courses in physics, chemistry, physiology, and astronomy means of testing desirable outcomes other than the mere acquisition of facts. He illustrates his discussion with abundant examples of the various types of test employed. —F.D.C.

SWIEGERT, R. L. "Engineering Science and Education—Conflict or Coöperation." *The Phi Delta Kappan* 16:139–141; December, 1933.

A clear presentation of the issues involved as between the point of view of the subject-matter specialist and that of the specialist in method. The extreme point of view held by some educational experts is illustrated by that of an educator trained in supervision but with no knowledge of subject-matter who applied for a position as supervisor of instruction in the division of chemistry.

"He might have been able to supervise the teaching of supervision, but not being adequately trained in the field of chemistry, he certainly would have been unable to supervise instruction in chemistry. To supervise in any field the educational man must be thoroughly familiar with the field. . . . Supervision and improvement in education must be from within the subject-matter field."

The harm that this attitude does by causing science specialists to think ill of education is pointed out. The other point of view is then presented.

"We have too many subject-matter friends and specialists who are so far down in a hole that they have long since lost contact with the rest of the world. Perhaps the majority approach that type in scientific and engineering education. . . . The extreme subject-matter specialist knows thoroughly at least a section of his general subject but in many cases he is unable to interest the student, and he is unable to put the subject-matter across to the student at all or he is unable to put it across in any manner that economically allows the student to gain the training himself."

The remainder of the article points out how the recognition of the proper place of each type of training will work for coöperation and result in gain on both sides. —O. E. Underhill.

STOWE, A. MONROE. "The Professional Training of High-School Teachers." *The High School Journal* 17:4–8; January, 1934.

Is the work of teaching a profession or semi-skilled labor? Why should the graduate faculty of a University be any more responsible for the professional training of teachers than for such training for prospective doctors or lawyers. These and other problems relating to the professional education of teachers are raised and discussed. It should be read by those who feel that a thorough grounding in subject-matter attained through study in a liberal arts college is sufficient preparation for high-school teaching.

—O. E. Underhill.

Symposium. *Annotated Bibliography of Research Studies.* New York: Institute of School Experimentation, Teachers College, Columbia University, 1934. 15 p.

This is an annotated bibliography of the research studies carried out by members of the Institute of School of Experimentation, Teachers College, Columbia University, during the period June, 1931, to February, 1934. Eighty-six studies are listed as either completed or in progress. More than half of these studies are in the field of science education. —C.M.P.

KOOS, LEONARD V. "Selected References on Secondary-School Instruction." *The School Review* 42:59–66, January, 1934.

An annotated bibliography of references relating to the curriculum, methods of teaching and study and supervision and measurement.

—C.M.P.

BRUNER, HERBERT B. "Some of Education's Opportunities and Obligations in the Present Crisis." *Teachers College Record* 35:213–221, 310–322; December, 1993, and January, 1934.

In part one of this article the author makes a timely and critical analysis of the question "Under What Kind of 'Economy Do We Live?'" Part two discusses the question "What Have the Schools Done?" In conclusion the author believes that the new school program (1) will utilize the materials of the community and (2) will utilize concrete illusrations and not treat abstract theories. —C.M.P.

CONRAD, CLINTON C. "Teachers' Marks." *University High School Journal* (California) 13: 53–66; December, 1933.

This is an excellent common-sense discussion of the purposes of teachers' marks. "A good teacher considers the objectives of his course thoughtfully, and attempts to measure fairly, judiciously and honestly the achievement of his students toward these objectives." —C.M.P.

MARTIN, ROBERT E. "Experts Seek Way to Save World's Vanishing Records." *Popular Science Monthly* 124: 32–33, 110; March, 1934.

This is an illustrated article presenting the various methods that are being used to preserve man's vanishing records, especially his written records as found in books and newspapers. A building known as the National Archives Building is now being constructed in Washington to house the precious records and documents of the government.

—C.M.P.

SCIENCE EDUCATION—GENERAL

SKEWES, GEORGE J. "What is a Scientific Attitude?" *School Science and Mathematics* 33: 964–968; December, 1933.

This interesting article described an attempt to determine the various elements included in a scientific attitude. A questionnaire containing sixteen possible scientific attitudes was submitted to 250 experienced science teachers, who were asked to indicate by "yes" or "no" their judgments of whether each point represented a characteristic of scientific attitude. Replies were received from 162 teachers. Various sets of tests to measure the attitudes thus selected and approved are promised. The attitudes with the opinions of them expressed by the evaluators are included in this report.

—F.D.C.

DAVIS, IRA C. "Is This the Scientific Method?" *School Science and Mathematics* 34:83–86; January, 1934.

In this thought provoking exposition of progressive teaching Davis describes the procedures followed by an eighth-grade class in general science in attacking the problem, "How can I find out how hard the water is we use at home?" He gives a careful and complete exposition of the steps followed under these headings, (1) Controls and variables; (2) Establishing the controls; (3) Establishing standards for results; (4) Accuracy of results; (5) Cost of equipment; and (6) Is this the scientific method? —F.D.C.

HURD, A. W. "Sex Differences in Achievement in Physical Sciences." *Journal of Educational Psychology* 25:70; January, 1934.

One hundred thirty-four boys were matched with an equal number of girls in physics classes on the basis of chronological age, grade and instructor. Comparisons on objective achievement tests before and after instruction on a unit dealing with "Electric Lighting Systems" showed a marked initial superiority for the boys. This superiority was much less on the final test, although still substantial. The girls were superior with respect to gains made and the sexes were very nearly equal in the per cent of possible gain actually achieved. The data suggest that the previous training of the girls in the subject-matter of physics was deficient as compared with that of the boys, but that the girls make up part of this deficiency, although the boys are still superior on the final test and at least even on the per cent of possible gain achieved. —V.H.N.

GARARD, IRA D. "The Scientific Method and the Popular Mind." *Education* 54:129–134; November, 1933.

The author discusses the extent to which the populace is trained in the use of the scientific method. He points out differences between science and the scientific method. He indicates reasons why elementary and secondary schools have failed to train young people in the use of this method. This failure on the part of our public schools and the fact that such a large percentage of the population does not go beyond the high school are largely responsible for the lack of application of the scientific method in popular thinking. This failure is extended into the college where emphasis is placed commonly on science content rather than on the method of work. The author points out difficulties in applying the scientific method in the fields of business, politics, government, economics, sociology and social welfare.

—F.G.B.

HESSLER, JOHN C. "Growing Up With Science." *Education* 54:147–149; November, 1933.

In order that the child may gain the scientific point of view so necessary to citizens in our modern state, Hessler emphasizes the need for beginning science education early, along with "numbers and reading in the first school years" and not waiting until the junior-high-school period when often the challenging questions of science have come too late. By beginning science work in the early grades, the child will have an opportunity to "grow up with science," to organize and appraise his daily experiences, and to orient himself in relation to his constantly changing environment.

—F.G.B.

BAKER, ROSS A. "Science Training for Civic and Business Administration." *Education* 54:139–142; November, 1933.

The author points out that an understanding of the scientific method is essential in successful civic and business administration. Although the administrator cannot be expected to be a specialist in the fields of science, it is necessary that he is able to apply the scientific method in solving the various problems which confront him and that he knows where to find and how to verify the points he needs in working out these problems. Or, if this is impossible, he should, at least, know when and how to use the services of experts.

—F.G.B.

BEAUCHAMP, WILBUR L. "Résumé of Instruction in Science." *Education* 54:135–138, November, 1933.

The author presents a brief summary of Bulletin No. 17, 1932, Monograph No. 22, Office of Education, U. S. Department of Interior, entitled *Instruction in Science.* This is one of a number of studies made in the National Survey of Secondary Education.

The purpose of this study "was to discover the changes which have taken place in the science curriculum with particular emphasis upon the discovery of promising innovations." To find out what changes have taken place in the science curricu-

lum, 58 courses of study in general science, 45 in biology, 27 in physics, and 30 in chemistry were investigated. Fourteen cities were visited to learn to what extent the courses of study functioned in the classroom and to study "promising innovations in the courses of study." The author concludes that there is "great confusion as to the methods to be employed in teaching science" and "that beyond the topics to be taught, the course of study has little effect upon daily teaching."

—F.G.B.

Naylor, Nellie M. The Usefulness of Introductory Chemistry in Home Economics Curricula. *Education* 54:143–146, November, 1933.

The author considers briefly the ways in which elementary chemistry may be adapted to meet the needs of special groups of students, such as those specializing in home economics, engineering, agriculture, and medicine. She then discusses in detail the ways in which introductory courses in chemistry may function in preparing home-economics students to meet intelligently problems in subsequent courses and also the ways in which these students may apply chemical principles in the various vocations in which they may engage after leaving school. —F.G.B.

Noll, Victor H. "Teaching the Habit of Scientific Thinking." *Teachers College Record* 35: 202–212, December, 1933.

This is the second of a series of articles on scientific thinking, the first of which appeared in October, 1933. The present article discusses the following theses: (1) The natural sciences present some of the best though not the only materials for use in forming habits of scientific thinking; (2) No one method of instruction is peculiarly and solely appropriate for teaching scientific habits of thinking; (3) The habits of thinking that were listed as constituting the scientific attitude should be taught and developed directly as such; (4) Practice must be given in the formation of these habits in specific situations; (5) The habits that constitute scientific thinking should be generalized, and (6) Opportunity for practice in scientific thinking must be given in all possible situations. —C.M.P.

Hurd, A. W. "Some Aspects of the Education of Teachers of Science in State Teachers Colleges and Normal Schools." *Educational Administration and Supervision* 20:35–44; January, 1934.

This is a résumé of an investigation whose purpose it was to determine what type of science courses were being given to prospective teachers in state teachers colleges and normal schools. There seems to be a definite tendency toward offering professionalized subject-matter courses in science, the introductory course being of an orientation or survey course. The major topics considered in several of these orientation courses are included to illustrate what type of subject-matter is actually being given in these courses in various institutions. A list of ten textbooks of an orientation or survey nature is appended.

—C.M.P.

Hill, A. V. "The International Status and Obligations of Science." *Scientific Monthly* 38: 146–156; February, 1934.

Science and learning alone seem to be truly international, to be capable of transcending national follies and absurdities. It is one of the supreme obligations of science to see to it that it knows no political, racial, or religious boundaries.

—C.M.P.

Frutchey, Fred P. "Measuring the Ability to Apply Chemical Principles." *Educational Research Bulletin* (Ohio State University 12:255–260; December 13, 1933.

This is the résumé of an attempt to measure objectively the ability of students to apply chemical principles in solution of certain problems involving a series of chemical facts. —C.M.P.

SCIENCE IN HIGH SCHOOL

Clark, John D. "A New Periodic Chart." *Journal of Chemical Education* 10:675–677; November, 1933.

The author points out the defects of existing periodic tables and presents a chart which he believes not to have these defects. —V.H.N.

Sanford, William B. "Wood Distillation Model." *Journal of Chemical Education* 11:45–46; January, 1934.

A description of a furnace and condensing apparatus made by high-school pupils for the destructive distillation of wood. Methods used in separating the products of distillation are also described. —V.H.N.

Garard, Ira D. "Scientific Method in General Chemistry Laboratory Work." *Journal of Chemical Education* 11:42–44; January, 1934.

The author suggests that students in chemistry do not learn the scientific method because laboratory instruction and particularly existing laboratory manuals do not make scientific method an objective. Laboratory manuals are too much like cook-books. If each laboratory exercise was prefaced with a statement of the object of the experiment and the explanation and directions were such as to lead the student to the accomplishment of the object, the author believes more training in scientific method would result. Also, he suggests, among other things, that each exercise should contain a single problem, and that the experiment should be selected so as to emphasize and require the use of scientific method. —V.H.N.

SEGERBLOM, WILHELM. "Laboratory Work in Teaching Elementary Chemisry." *Education* 54:159–163; November, 1933.

The author discusses an investigation "to study the laboratory, its conduct, content, and relation to the textbook work" of the chemistry class as carried on in high schools in the New England States. This study gives a clear picture of the laboratory situation in the teaching of chemistry in 100 widely varying types of secondary schools that participated in the study. —F.G.B.

DIAMOND, LEON NORDAU. "The Testing Movement in High School Biology." *School Science and Mathematics* 34:39–49; January, 1934.

This article follows a brief description of each of 14 biology tests with a short discussion of the merits and shortcomings of each. These discussions of the individual tests are based upon an analysis including total questions, types of question, sources utilized in making the tests, and objectives measured. —F.D.C.

Symposium. "Our Clothing." *The Science Leaflet* 7:1–25; December 21, 1933.

Both natural and synthetic materials that go to make up our clothing are described in this interesting number of *The Science Leaflet*.

—C.M.P.

Symposium. "Our Houses." *The Science Leaflet* 7:1–14; January 11, 1934.

The Chicago World's Fair included as one of its most interesting exhibits a series of houses and house furnishings portraying the American home of today and tomorrow. This illustrated leaflet describes the materials, many both new and synthetic, used in some of these more up-to-date homes. —C.M.P.

FEDERER, GEORGE A. "The Teaching of Integrated Physical Science in the West Virginia University High School." *Educational Method* 13: 271–273; February, 1934.

The writer makes several points in this article worth noting, although, as he realizes, they are not new—merely reiterations. The first is the idea of integrated units of instruction in the last two years of the high school to replace the present rather traditional courses in physics and chemistry. The second makes it clear that integrated units do not have the purpose of making science work easy. The third indicates the inadequacies of present courses in science in preparing people for life.

Some good examples of practical integrated topics are then mentioned and a brief account given of some features of instruction with the units in the school.

The final point that integrated units will not prepare the pupil for college science is combated by citing data which prove that there is little relationship between the present pattern of high-school subjects and success in college. Undoubtedly the use of integrated, general science units will not militate against success in college science. —A.W.H.

Anonymous. "Salvaging the 'Lutine's' Gold." *Popular Mechanics Magazine* 61:1–3; January, 1934.

This may serve as an interesting and "up-to-date" illustration of the use of compressed air in a caisson, in connection with teaching about air pressure. A good diagram is given.

—O. E. Underhill.

SCIENCE IN ELEMENTARY SCHOOL

MEIER, W. H. D. "Trends in Elementary Science Education." *Education* 54:150–153; November, 1933.

An examination of the courses of study in science used in leading school systems shows clearly defined trends, such as a tendency toward a well-balanced program of work, science training beginning in the first grade and extending as a continuous integrated program of study through the secondary school, clearly defined objectives which function in the selection of materials included in the courses of study, organization of content into units of study, and an emphasis on use of local materials as illustrations in the development of outlines of study.

The author briefly compares the work in science in elementary schools of England and Germany with the work in the United States —F.G.B.

PALMER, E. LAURENCE. "Sound." *Cornell Rural School Leaflet* 27:3–32; January, 1934.

This illustrated leaflet may be rated as one of the best pamphlets that has been prepared on the topic sound. Elementary science teachers will find it useful; it will be valuable to junior high and senior high school teachers, as well.

—C.M.P.

BRONSKY, AMY. "Elementary School Geography and World Problems." *The Journal of Geography* 32:316–322; November, 1933.

Elementary geography may be made to contribute to the solution of world problems if the organization of the work is such as to make thinking rather than remembering the central point of learning. The article discusses: Raising problems and purposes; activity essential to thinking and learning; importance of attitudes; make understanding the basis for attitudes; wide reading; receptiveness to change; and coöperative school learning. —C.M.P.

CLARK, AUSTIN H. "How Animals Spend the Winter." *Scientific Monthly* 38:170–173; February, 1934.

Animal life wherever found does not cease during the winter months—it either migrates, slows down, or practically comes to rest. —C.M.P.

SCIENCE

Bhagvat, R. N. "Knowledge of the Metals in Ancient India." *Journal of Chemical Education* 10:659–666; November, 1933.

The inhabitants of India understood and practiced metallurgy thousands of years before the Christian era. The earliest metals mentioned in Indian literature were gold, silver and iron. The metallurgy of lead, tin and copper was practiced before the beginning of the Christian era.

—V.H.N.

Rutherford, Lord. "The Transmutation of the Atom." *Scientific Monthly* 38:15–23; January, 1934.

This is an excellent popular presentation of the scientific research that has been and is now being carried on to change one element into another—the dream of the alchemist—the transmutation of the atom. As Lord Rutherford puts it, "I know of no more enthralling adventure of the human mind than this voyage of discovery into the almost unexplored world of the atomic nuclei.

—C.M.P.

Anonymous: "Astronomy Film in Production." *The Educational Screen* 11:278; December, 1933.

An announcement of a film in production, for release in February to be known as *Looking Through Great Telescopes* which will give to audiences the experience of looking through the great telescopes of the world. It is to include a presentation of the latest theories of star formation. —O. E. Underhill.

Ginsberg, A. J. "An Aid to the Study of Optical Phenomena." *Educational Screen* 11:288; December, 1933.

A short description of an improved optical bench. —O. E. Underhill.

Anonymous. "Microbe Hunters Trail Latest Plague." *Popular Mechanics Magazine* 61: 10–12; January, 1934.

A short account of attempts to locate the cause of sleeping sickness. —O. E. Underhill.

Anonymous. "The Mystery of the Northern Lights." *Popular Mechanics Magazine* 61: 26–29; January, 1934.

Good photographs. Discusses various explanations which have been advanced to explain this phenomenon. —O. E. Underhill.

Anonymous. "Science Marches On." *Science News Letter* 34:403–416; December 23, 1933.

This issue of *Science News Letter* gives a résumé of the important achievements in each of the fields of science during 1933. —C.M.P.

Stokley, James. "February to be Month Without Full Moon." *Science News Letter* 25: 74–75; February 3, 1934.

In the usual illustrated monthly review of the stars that are visible during the month, the author calls attention to the rather rare occurrence—a month without full moon. —C.M.P.

Menge, Edward J. v. K. "Biological Progress in Latin America." *Education* 54: 154–158; November, 1933.

Important progress in biological fields made by the Latin American countries centers about factors, such as the founding of great universities; the outstanding work in relation to snake bites carried on at the famous snake farm in Sao Paulo, Brazil, in which have been trained the founders of all other snake farms in the world; the work in the Instituto Oswaldo Cruz, Rio de Janeiro, in connection with yellow fever, Chagas disease, and various tropical parasitic forms of life; important research in preventive and curative medicine carried on in the Biological Institute, Buenos Aires; studies by Carlos E. Porter, Chile, on the life history of Chile's only venomous spider; the work of Finlay of Cuba which foreshadowed all modern experimentation in yellow fever; the position of Costa Rica made possible through bringing eminent scientists from other lands to assist the native workers; and the studies of Mexican scientists relating to food and medicinal plants and agriculture. —F.G.B.

Harding, T. Swann. "The Revised Food and Drugs Bill—What It Means to You." *Scientific American* 150:68–70; February, 1934.

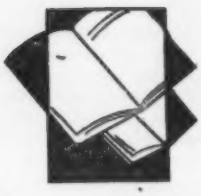
This is an article which points out deficiencies in the present Pure Food and Drugs Act and advocates the passage of the Copeland bill by the United States Congress. —C.M.P.

Cooke, Giles B. "Manufacture of Linoleum." *Journal of Chemical Education* 11:3–13; January, 1934.

Describes the making of linoleum, past and present. The raw materials are described and their manufacture and preparation for use in making linoleum are discussed. Following this is a detailed explanation of the manufacture of various types of linoleum including plain, printed and various inlaid and embossed types. The article also gives the various tests applied to the finished products and is well illustrated.

—V.H.N.

New publications



DEMING, HORACE G. *Introductory College Chemistry.* New York: John Wiley and Sons, 1933. 590 p. $3.00.

As indicated by the title, this book is intended as a text for college classes in elementary chemistry. The treatment is unusual in that the introduction is historical. Incidental historical matter is introduced throughout the text. This is exceedingly interesting to the reader with some knowledge of chemistry and some familiarity with the history of science. Whether or not it will serve as a stimulus to the new student to strive more diligently to master the facts of science involved must be left to the experimentation of the teacher, using the book, to determine.

The major divisions of the book are as follows: preliminary; the non-metals; the metals; and organic chemistry. The preliminary part includes the historical introduction; the treatment of oxygen, hydrogen, and water; acids, bases and salts; chemical symbols, formulas and equations; the states of matter; the nature of matter; and changes of state. The section on non-metals begins with the treatment of carbon and introduces much matter on the chemistry of fuels.. The section on metals begins with a survey of the metals and proceeds to the treatment of mortar and cement and the ceramic industries, and then to the treatment of iron and various iron manufactures. The section on organic chemistry includes a chapter on the chemistry of nutrition.

This text includes many more of the useful and interesting applications of chemistry than other introductory texts, although the author insists that the learning of chemical principles and concepts should take precedence in teaching objectives.

Teaching aids include many useful exercises, general reading references for each chapter and many specific references upon a wide variety of interesting topics. These latter references are chiefly references to chemical and industrial journals.

The author his listed paragraphs to indicate the treatment of general principles and other paragraphs for three types of courses, a course for engineers, for pre-medic and home economics students, and a cultural course.

The book is recommended as offering decided possibilities in increasing the interest in and usefulness of the beginning course in chemistry.

—R.K.W.

HENDERSON, WILLIAM D. *Physics Guide and Laboratory Exercises With Accompanying Tests.* Chicago: Lyons and Carnahan, 1933. 320 p. $1.00.

This is an outline of ten teaching units together with a preliminary set of exercises (not called a unit) on the language and tools of physics. Beginning with formal Unit I, each unit is introduced by a study outline and a list of, "What to do in this unit." A brief discussion gives the overview of the unit. Then follow exercises of a work book nature; exercises based upon laboratory experiments which are given in manual form; individual and group projects; topics for discussion; topics for further study and investigation; review suggestions; and a students' self test of the objective sort. The teaching units are the usual divisions of conventional physics. From the standpoint of the reviewer the book may be classified as a combination laboratory manual, work book, and test book. Any text may be used to accompany the book. It appears to be a carefully prepared book which will be of use to teachers of physics in high schools. —A.W.H.

HENDERSON, WILLIAM D. *The New Physics in Everyday Life.* Chicago: Lyons and Carnahan, 1930. 793 p. $1.60.

This is an entirely new book by an author of an older text. His plan is to present major subjects from an historical approach. From the pupil standpoint, he begins with familiar phenomenon and later develops principles. The book includes illustrative and explanatory exercises and citations to many practical applications of physical principles. The author has attempted to bring the book up to date by some discussion of talking pictures, television, and the like. It appears to the reviewer as one of the better textbooks in physics on the market. —A.W.H.

WEINBERG, LOUIS; SCOTT, ZENOS E. and HOLSTON, EVELYN T. *The World We Live In.* New York: D. C. Heath and Company, 1932. 266 p. $0.92.

This book is an introduction to geography suitable for pupils in the fourth and fifth grades. Due to the skillful correlation of geography, history, and civics, it is, at the same time, an elementary introduction to the social studies.

An experimental edition of the book was tried out and tested in widely distributed schools. Criticisms and suggestions received from superintendents, principals, and classroom teachers who worked with the material were incorporated in the final publication.

The illustrations are line drawings in black and white designed as teaching instruments. They are valuable in aiding the child in an interpretation of the content and are suggestive of further illustrations which pupils can make. A number of maps afford opportunity for a beginning of locational geography. The book is written in simple dignified style that attracts and holds the interest of pupils. After each chapter are sections entitled, "Things To Do"; "Questions To Answer"; "Puzzles," and "A Test To Try."

Teachers of geography and social science in elementary schools will welcome this stimulating book. —F.G.B.

Cole, Elbert C. *An Introduction to Biology.* New York: John Wiley and Sons, Inc., 1933. 518 p. $1.75.

This book embodies a year's work for first year in college. It is based on sound principles and treats fundamentals in a strictly scientific way. And yet the practical value of biology to every human being is never lost sight of. The dependence of all organisms upon inorganic matter; the interrelations of living things and man's increasing control over living things are among the important ideas stressed. Mechanically, the book is faultless; pedagogically, it has merit, and from the point of view of selection of material, it shows good judgment. The illustrations are especially good. The lists of projects, related readings, and references given, add much to the value of the book, especially for those whose ability allows them to cover more than the average of the class. There are forty-one chapters grouped into seven parts. The parts are as follows: (1) Organisms and Their Environment; (2) Life Activities of Plants; (3) Some Fundamental Processes in Organisms; (4) Man as an Organism; (5) Life Activities of Animals; (6) The Control and Improvement of Organisms; (7) The Kinship of Organisms. —W.G.W.

Parkins, A. E. (Chairman). *The Teaching of Geography.* Thirty-second Yearbook of the National Society for the Study of Education. Bloomington (Illinois): Public School Publishing Company, 1933. 615 p. $3.00.

This *Thirty-second Yearbook* is the most complete assemblage of materials relating to the teaching of geography that has yet been made. More than the usual number of *Yearbook* contributors have made possible this excellent contribution. Representing as it does all shades and varieties of opinion as to the teaching of geography, one would not expect to find a complete equanimity of opinion. In this expectation he is not disappointed. Not only will geography teachers find this *Yearbook* invaluable, but other teachers will gain a new viewpoint on some of the vexing problems in their own fields.

Section I is devoted to The Development of Geography and Its General Contributions To Life; Section II, Developing the Science of Teaching Geography; Section III, Geography in the Curriculum; Section IV, The Curriculum in Geography; Section V, The Technique of the Teaching of Geography, and Section VI, Investigations in the Teaching of Geography.

—C.M.P.

Langvick, Mina M. and Noll, Victor H. *U. S. Government Publications Useful to Teachers of Science.* Circular Number 48. March, 1932. Washington, D. C.: Office of Education, Department of Interior. 20 p. (Free.)

This circular is an annotated bibliography of United States Government publications that are useful to teachers of science in elementary and secondary schools. It gives a representative sampling of a large number of publications available for distribution through the Superintendent of Documents, Government Printing Office, Washington, D. C. The bulletins listed are, in the main, non-technical in character. References valuable for both pupil and teacher are given for various fields of study, such as: health, food, and safety; clothing accessories; injurious insects and pests; useful insects and birds; useful plants and their care; national parks; natural resources; maps and charts; standards of measurement; household equipment and materials; manufacturing and industrial processes, and weather and climate.

Every science teacher should have access to this bulletin. —F.G.B.

Malin, Joseph E. *Construction of a Diagnostic Test in the Mechanics and Related Fundamental of High School Chemistry.* Philadelphia, Penna.: University of Pennsylvania Press. 1932.

The purpose of this investigation is "(1) to determine what fundamentals of a mechanical nature in chemistry are taught in the secondary schools, (2) to determine what fundamentals are directly related to fundamentals of a mechanical nature, (3) to select for each mechanical process and its related fundamental a number of test exercises which will vary in difficulty, and (4) to indicate the uses and limitations of the test."

This test has been designed to diagnose the pupils' difficulties in the "mechanics" of chemistry. The author interprets the term "mechanics" to include properties of gases, the principle of writing equations, the principles involved in the solving of chemical problems, and an understanding of the principal laws of chemistry. As the result of such diagnostic procedure, certain remedial

measures can be proposed which will result in improvements in the methods of teaching and effective learning.

The first step in the construction of the test was to determine which high school texts are the most widely used in the secondary schools in the U. S. This was accomplished by scanning the literature for studies in which investigations had been made in the determination of representative chemistry texts in use in the secondary schools. The next step involved the analysis of the five selected texts and their manuals in regard to the selection of mechanics and related fundamentals of chemistry to be used in the tests. The selection of the items for the test was checked by comparing it with an analysis of the college Entrance Board Examinations covering a period of eleven years. The selection of the mechanics and its related fundamentals was further checked by questionnaire data from city school systems to show that this content is actually being taught in the chemistry classes of secondary schools.

The next step served as another check upon the textbook analysis, and consisted of an analysis of the five textbooks and manuals on the basis of the per cent of total space occupied by each topic. After the completion of the first analysis of chemistry texts, one form of the test (A) was constructed and tried out; this was then, in the light of the results and the constructive criticism of the seminar group in secondary education, revised and the second form (B) of the test was constructed. Later these tests were further modified and called forms X and Y respectively.

The principal criteria for the selection of material in the construction of Form A and Form B are the criteria of errors and of the analysis of textbooks. Other criteria which have served as checks upon the material already selected are an analysis of the College Entrance Board Exams (1917–1927), a course of study as proposed by the American Chemical Society, questionnaire data collected by the Central Association of Science and Mathematics Teachers, and the questionnaire data collected by the author. . . . these criteria establish the validity of the diagnostic test.

This comprehensive study is the only one of its nature which has for its primary function the diagnosis of class and individual difficulties instead of measuring achievement. It has carefully recorded the tabulation of the exact errors and the types of error, the number of times each occurs, and the per cent of their occurrence in terms of the total number of pupils taking the test. All the types of errors were analyzed carefully, as well. This proposed test differs from the others in this field in that the exercises in one part of the test are arranged in steps based in part upon the analysis of errors made by the pupils in the preliminary testing and in part upon the analysis of the operations required in a given ability. Thus it will yield data which will improve subsequent teaching in high school chemistry.

—Jack Epstein, New York University.

COBURN, WALTER E. *High School Electricity Manual.* New York: John Wiley and Sons, Inc. 1932. 126 p. $1.35.

The function for which this book is designed is best stated by a few sentences from the preface:

". . . the author has selected the material for this book from a standard trade analysis and arranged it for use in high schools and vocational schools. . . . the theory of electricity is worked out almost entirely by experiments definitely related to actual production jobs which the student is required to perform. The text is written for senior high school students in industrial arts courses where electricity is usually required for two terms, or for the first term's work in any vocational electricity course."

Eleven of the exercises are of a more or less technical nature, and twelve "jobs" range from the installation of bells and annunciators to the rewinding of vacuum cleaners and automobile generator armatures and installation of motors.

—O. E. Underhill.

RARIG, FRANCES H. *The Ant Queen's Home and Other Stories.* New York: D. C. Heath and Company, 1932. 10 p. $70.80.

This interesting book gives authoritative information about the life activities of agricultural ants, honey bees, wasps, dragonflies, butterflies, and spiders. The author's fascination for these forms came about as a result of actual experiences which she passes on to her readers in a delightful manner. The clear pictures of the activities of these animals as given in the stories will stimulate young readers to want to know more about the animals. The book is illustrated by line drawings.

Boys and girls in fifth and sixth grades will be especially interested in this book which may be used as a supplementary reader in science or as a book in the school and home library. —F.G.B.

FULLER, RAYMOND T. *Along the Brook.* New York: The John Day Company, 1931. 81 p. $1.50.

A brook is one of the most fascinating haunts in Nature for those who know the varied life in its water and on its banks. *Along the Brook* is designed to give an intimate acquaintance with living things that accompany a stream. The author describes fifty common animals and plants and tells many interesting details about their homes and their habits. To further aid in identification, each discussion is illustrated by a line drawing. The author describes simple equipment used in collecting brook animals, tells how to make some common pieces of equipment, and gives suggestions about the care of forms collected.

This is a valuable handbook for children and adults who are interested in knowing the life that accompanies small streams. —F.G.B.

Hylander, Clarence J. *The Year Round.* New York: G. P. Putnam's Sons, 1932. 273 p. $2.00.

This book will be welcomed by teachers, camp leaders and parents because it offers assistance to young people in identifying common plants and animals. The purpose of the book is clearly instructional. It is written in an inviting narrative style. The ecological treatment of forms assists the reader in remembering the plants and animals that belong together in different types of environments. The seasonal arrangement of materials simplifies identification because the forms not found at a given season are eliminated. The keys for identification of flowers, trees, ferns, butterflies, birds, turtles, snakes, sea shells, and rocks are clearly designed for use by young people.

This nature guide should occupy a unique place in helping children discover and recognize common forms in the out-of-doors. —F.G.B.

Ashbrook, Frank G. *The Blue Book of Birds of America; The Red Book of Birds of America;* and *The Green Book of Birds of America.* Racine, Wisconsin: Whitman Publishing Company, 1931. 96 p. $0.10 each.

These three books make up a series of guides of pocket-size designed to aid in identification of common birds, to furnish information about birds, and to stimulate interest in their habits. A colored picture of each bird together with the scientific name, size, and a discussion of range, nest, eggs and habits is given.

The Blue Book includes the orders of goatsuckers, swifts, etc., and perching birds including the tyrant flycatchers, larks, crows and jays, starlings, and finches. *The Red Book* features the orders of diving birds, swimmers, herons, storks, ibises, marsh dwellers, shore birds, pigeons and doves, birds of prey, cuckoos, and woodpeckers. *The Green Book* takes up the orders of perching birds including tanagers, swallows, waxwings, shrikes, vireos, warblers, pipits, dippers, mimic thrushes, wrens, nuthatches and creepers, titmice, wren tits, kinglets, gnatcatchers, and thrushes.

The small cost of these books makes possible a wide general distribution of information relating to birds. Their pocket-size enables children and adults to carry them conveniently in fields, woods, or on highways. —F.G.B.

Shaw, Sir Napier. *The Drama of the Weather.* New York: The Macmillan Company, 1933. 269 p. $3.50.

All of us are concerned about the weather. Every man makes either some attempts at weather prediction or criticizes the predictions of the professional weather prophets. Here is a scientific treatise on the weather for the lay reader. The author is a British scientist of international repute who has served as president of the International Meteorological Committee. While entirely scientific in spirit, the book has real literary merit and holds the interest of the reader from first to last.

The prologue on the pageantry of the sky includes a beautiful set of photographic illustrations to help the reader in visualizing cloud types and their significance. There is a very interesting chapter upon the history of weather lore and prediction. Scientific instruments for weather prediction are explained, along with the operation of instruments, which the laymen may use for himself.

The author is more concerned with a real explanation of weather phenomena than with prediction. Later chapters deal with the latest findings concerning the air and atmospheric movements. Less faith is placed upon the old type air maps, plotting short range movements of air from highs to lows. More stress is given to the attempt to explain the weather in terms of large movements of the atmosphere as influenced by mass movements of cold air from the poles and warm air from the tropics.

This is a book to be widely read. Science teachers are urged to become acquainted with this volume. —R.K.W.

Atwood, William H. and Heiss, Elwood D. *Educational Biology.* Philadelphia: P. Blakiston's Sons and Co., 1933. 475 p. $2.75.

This is the second edition of a book that has been used extensively in teacher-training institutions; it has also had wide use in colleges and universities as a text in general biology.

Materials in the first edition have not been omitted from the second edition but there has been some reorganization of them. Topics relating to vitamines, heredity, eugenics, and evolution have been expanded; special attention has been given to clarification of expression; and many excellent illustrations have been added.

This new edition of a tested book is a valuable contribution in the field and will be welcomed by teachers of biology on the college level.

—F.G.B.

Hector, L. Grant. *Introductory Physics.* New York: American Book Company, 1933. 372 p. $3.00.

The essential feature of this introductory college text is its re-organization in terms of modern physics. Not only does the organization attempt to develop with beginning students the new physics, but the terminology of the major divisions of the subject-matter is also modern. A sampling of the contents will give a hint of both the terminology and the organization. Some major divisions are as follows: the scope of physics and the world of atoms; force, work and mass; statics; kinetics; dynamics; power; machines; sound; speech and hearing; the science of musical sounds; architectural acoustics; temperature and heat; heat and work; behavior of gases; buoyancy; electrical fields and potentials; electrical capacity; effects of electric currents; magnetic materials; electromagnetic induction; electromagnetic generators; electronic tubes; X-rays and radium; spectroscopy and atomic structure; light.

The treatment of individual topics is brief and clear. The author frankly expects students to

find other details in larger reference works. Formulas are numerous so that training in mathematics will be of material aid in following the content. Practically all illustrations are line diagrams to aid the explanatory material of the text. Numerous problems occur at the ends of chapters. Each chapter is introduced by a brief summary of what may be expected in the following development.

College teachers of introductory physics should examine this text. High school teachers will find it a useful and up-to-date reference.

—R.K.W.

KINSEY, ALFRED C. *New Introduction to Biology.* Philadelphia: J. B. Lippincott Company, 1933. 840 p. $1.68.

This high school biology text is a revision of the author's earlier *Introduction to Biology.* The rearrangement of this new edition should make for a decided improvement in ease of teaching the material. Notably, there is much less emphasis upon classification, as such, in this edition.

The material is divided into eight large divisions, called units. These are: taxonomy, distributional biology; morphology; physiology; genetics; ecology; behavior; and a conclusion which includes a history of biology and a chapter on scientific method.

The book is large. This will operate as an advantage, if the teacher will select from the material presented that which best fits the needs of particular classes. There is a wealth of illustration—the pictures and diagrams are well done.

Teachers who are concerned about an exact logical fitting together of the courses which they teach will be somewhat troubled with the loose organization of the subject-matter. There is little or no attempt to relate particular chapters to preceding and following parts. Apparently the author assumes that the material of each chapter will be inherently interesting to the pupils and that the sequence of parts of the text or course are of little importance.

The book is recommended for the consideration of high school teachers of biology.

—R.K.W.

MOTT-SMITH, MORTON. *Heat and Its Workings.* New York: D. Appleton and Company, 1933. 240 p. $2.00.

This is one of the volumes of the Appleton New World of Science Series, edited by Watson Davis, editor of *Science Service.* The book is intended for the lay reader without special training in science. The introduction is journalistic in style. The treatment includes both recent findings and the historical development of theories, with the emphasis upon the historical development. There are some mathematical formulæ and charts.

The book is recommended to the general reader and to the high school and college librarian. It is probable that high school pupils, other than those enrolled in senior high school courses in physics and chemistry, will not read it with a great deal of understanding. —R.K.W.

WISE, W. E. *Thomas Alva Edison: The Youth and His Times.* Chicago: Rand McNally Company, 1933. 230 p. $2.00.

This well-advised selection of the Junior Literary Guild is one of the best biographies for young people that has come to the attention of the reviewer. It tells clearly and in a very interesting and readable manner the development of young Edison in relation to the times in which he lived. The author with a few sentences or a short paragraph here and there skillfully sets the framework of the period in which Edison grew up. Although the story ends with Edison's twenty-third year references, his later achievements are so made in connection with the earlier experiences, out of which his later work grew, that one has a well-rounded picture of his complete career. The way in which this inventor gained his knowledge of science and the way in which he contributed to the progress of applied science is handled in such a manner as to make it especially useful as supplementary reading in connection with the teaching of science. —O. E. Underhill.

MILLER, FRED R. *Progressive Problems in Physics.* Boston: D. C. Heath and Company, 1933. 225 p. $1.32.

This is a complete revision of an earlier edition. It includes hundreds of problems covering the conventional divisions of high school physics. They are arranged in progressive order so that the subject is developed step by step. In addition to the regular list of problems there are samples of college entrance board and Regents' examinations, and an appendix of useful tables including squares, square roots, reciprocals, and four-place logarithms. —A.W.H.

MANK, HELEN G. *The Living World.* Chicago: Benjamin H. Sanborn and Company, 1933. 673 p. $1.68.

In *The Living World* we have an interesting, modern text well adapted to the needs of all high school pupils, regardless of what courses they are taking. A "work program" covering field and laboratory experiment and observation precedes the material in each unit. There are lists of suggestive questions and review tests at the end of the units. The book probably covers more ground than the average pupil can assimilate, but this merely offers the teacher a choice of material. The author's style is easy, informal, and interesting. The illustrations are well selected, and, altogether, the book seems to be of such character as to engage the interest of the pupil. —W.G.W.

EDWARDS, LAWRENCE. *The Spangled Heavens.* Philadelphia: J. B. Lippincott Company, 1933. 115 p. $1.25.

This book was written by a youthful British astronomer and includes an introductory statement from the *Astronomer Royal.* Although written and published in England the language will appeal to young Americans as well as to their English cousins. There are fewer technicalities and fewer large numbers than is customary in popular books

on astronomy. The interest of the reader is exceedingly well sustained. There are twenty-two photographic and diagrammatic illustrations that add much to the interpretation of the text.

The content includes a brief treatment of each of the following: the solar system; sun; Mercury; Venus; earth and moon; Mars; Jupiter; Saturn; Uranus, Neptune and Pluto; comets and meteors; the stars; the constellations; variable stars; double stars and star-clusters; nebulæ; the Milky Way; globular clusters.

The book is recommended to the lay reader, both young and old. High school librarians and science teachers will find it excellent for all pupils beginning with the junior high school and continuing through senior high school. —R.K.W.

Disraeli, Robert. *Seeing the Unseen.* New York: The John Day Company, 1933. 142 p. $2.00.

This is a very unusual book for the popular reader and experimenter, dealing with what may be seen with a microscope. The text deals with descriptive material concerning the objects to be examined and with suggestions on the technique of handling the microscope and the objects. Of even greater interest are the very fine photo-micrographs used as illustrations. These occur on every alternate page. An excellent feature of these illustrations is their large size. The pages of the book are 6 x 9 and many of the micro-photographs occupy the full page.

With the recent popularization of inexpensive microscopes for the young and the amateur, this volume will meet a real need. The reviewer had difficulty in retaining possession of his copy, in competition with a small daughter, long enough to write this review. As a gift to the budding scientist or a highly prized addition to the elementary school or high school library, this book is to be recommended. —R.K.W.

Brewer, John M. *Education as Guidance.* New York: The Macmillan Company, 1932. 668 p. $2.75.

As might be expected from the writings of this author, he has become an ardent adherent of the concept of education as guidance. Education is for the purpose of helping people to live more satisfying, more happy, and more complete lives. The most important word to use then, in thinking about and planning the school curriculum is the word activity. All knowledge and wisdom should center around the activity of pupils. The only genuine curriculum is learning to live. This thesis is expounded in the first chapter of the book.

From this thesis, the author seems to be in quite close accord with the seven cardinal principles of education revised to suit his modified conception of these principles. He discusses at length educational guidance, guidance for home relationships, guidance for citizenship, vocational guidance, guidance for leisure and recreation, guidance in personal well-being, religious guidance, guidance in right doing, guidance in thoughtfulness and coöperation, and guidance in wholesome and cultural action. He is interested in putting across a point of view which can hardly fail to appeal to the unprejudiced person. His plan for the present seems to be the creation of departments within the school system to give special attention to these features with the idea that the teachers of the present conventional subjects may improve their selection of content and methods by a studied consideration of this viewpoint of guidance. Eventually he expects great changes in our school curricula as an outcome of this attitude on the part of teachers and curriculum builders.

—A.W.H.

Hughes, Avah W. *Carrying the Mail.* New York: Bureau of Publications, Teachers College, Columbia University, 1933. 253 p. $2.25.

The author illustrates the way in which the environment of city children was used in developing the second grade program of Lincoln School, Teachers College, Columbia University. She shows how the intellectual interests of the children were focused upon one phase of city life after another as the year's work progressed. She points out that through study and spontaneous play in building a play city and in carrying on activities of its citizens the children learn to understand and interpret their social life, economic problems, and the city environment with which they are closely associated. One center of interest, that of "Carrying the Mail," is discussed in detail in order to trace the development of a specific interest.

In this discussion many important problems concerning the development of a unit of work are considered. The author skillfully describes "the differences between skills and techniques, facts and meanings, and knowledge and social implication." The author also points out the interrelation between activities and group discussions and indicates how activities and group discussions function in the development of oral and written composition. With unusual skill it is shown how the leads of pupils are explored, how their information is clarified and extended, and how creative activities are encouraged.

Excellent photographic illustrations show various phases of work in the development of the unit.

This book gives an insight into a method of work used in Lincoln School. It should be of interest to every primary teacher. —F.G.B.

Ridgley, Douglas C. *General Circulation of the Atmosphere.* Bloomington, Illinois: McKnight, 1933. 32 p. $0.15.

This pamphlet deals with the wind belts of the earth and present facts and principles of the atmospheric circulation necessary to a correct understanding of the amount and distribution of the rainfall of the earth. It is well adapted for use in upper grammar grades, junior high-school and senior high-school geography classes.

—C.M.P.

News and announcements

MINUTES FOR THE CLEVELAND MEETING OF THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

Cleveland, Ohio, Feb. 25, 26, 27, 1934
Headquarters: Hotel Cleveland

The dinner meeting was held at the Hotel Cleveland on Sunday evening, February 25, at 6:30 P. M. The following members were in attendance: Clarence E. Baer, R. C. Bedell, Florence G. Billig, Otis W. Caldwell, Harry A. Carpenter, Gerald S. Craig, Francis D. Curtis, Harry A. Cunningham, Ira Davis, Elliot R. Downing, J. O. Frank, Benjamin Gruenberg, E. D. Heiss, John Hollinger, A. W. Hurd, Morris Meister, Victor H. Noll, Ellsworth S. Obourn, Ellis Persing, Charles J. Pieper, S. Ralph Powers, Clarence M. Pruitt, W. F. Roecker, C. L. Thiele, Ralph K. Watkins, H. A. Webb, W. G. Whitman, E. E. Wildman, and G. C. Wood.

The meeting was called to order by the president, Dr. Ralph K. Watkins. The first item of business was the report of the Committee to Consider the Advisability of Reducing the Annual Dues. In the absence of the Chairman the report was presented by Dr. J. A. Hollinger. The report follows:

The annual dues of the N.A.R.S.T. have been $5.00 since the formation of the organization. The question as to the advisability of reduction of the annual dues arose at the meeting in Minneapolis in 1933, after which this committee was appointed.

A letter was sent to each member to ascertain his opinion. A copy of the form letter sent is attached to this report. Replies were received from thirty-six.

Of these, twenty-two indicate that the amount of dues should depend largely on the policy of the association with regard to future work, and that although as stated in some cases a reduction would be welcome, if the present fee is necessary to support the association and continue its standards, the present fee should be maintained.

Seven suggest an outright reduction in the annual dues in so far as the finances of the association will allow.

Seven recommend an unqualified reduction in the annual dues.

Suggestions as to the possible use of the surplus funds of the organization were as follows:

(1) The fund might be used to support a yearbook of the association;

(2) The money should be spent on worthwhile activities connected with various problems in the teaching of science;

(3) More allowance should be given to SCIENCE EDUCATION in order to give it better support. One suggestion was made that more stock in SCIENCE EDUCATION be bought looking towards eventual ownership of the magazine; another letter advised against such a move. (In referring to the journal we are reminded that the new subscription rate is now $2.00.)

The replies in some cases showed a tendency to connect the problem of reduction of dues with increase in membership. A relation was also suggested between our committee and the movement towards a central organization for science.

In view of the nature of the replies received, the committee recommends that the question of policy with regard to the use of the surplus funds of the association be brought up for discussion at the meeting at Cleveland and that the question of the advisability of reducing the annual dues be made contingent upon the policy adopted.

W. F. ROECKER,
J. A. HOLLINGER,
MRS. LOIS MEIER SHOEMAKER,
Chairman

It was regularly moved and passed unanimously that the report of the committee be accepted.

The report of the commitee to consider the possibility of an enlarged organization or the forma-

tion of a National Council of Science Teachers was made by the Chairman, Dr. R. K. Watkins. In connection with this report Dr. Caldwell spoke briefly concerning the purposes of the meeting held at Boston during the time of the meeting of the American Association for the Advancement of Science. A summary of his remarks are here presented:

The Committee on the Place of Science in Education and other officers of the A. A. A. S. during the past few years has received numerous suggestions that some sort of national meeting of science teachers in secondary schools be held. As a result of these suggestions, the Council of the A. A. A. S. at the last Chicago meeting, instructed the Committee on Place of Science in Education to prepare a one-day program to be held in connection with the recent Boston meetings. To this program we invited delegates and individual science teachers. At least 15 science teachers' organizations were represented; something more than 100 persons attending the program. During the discussion of the desirability of some sort of national organization of science teachers, it was suggested that the Committee on Place be asked to prepare a similar program for next year's meeting at Pittsburgh and that the discussion of the national organization be given opportunity for further consideration at that time. This suggestion was voted unanimously. It was also voted that a cooperating commitee be appointed to work with the Committee on Place, etc., in the formation of the Pittsburgh program. By vote, Dr. Harry A. Carpenter, of Rochester, was made chairman of this cooperating committee, he being instructed to appoint the other members of his committee.

It is the desire of the A. A. A. S. Committee to cooperate with science teachers in any way that may serve the interests of improved science. The Committee desires to help develop each of the organizations already in existence to the end that any national organization that may be formed will strengthen and not inhibit the functions already being performed by other organizations. The Committee desires suggestions concerning the best ways to develop the proposed Pittsburgh program. It has already taken steps to secure cooperation from those in and about Pittsburgh.

Mr. Carpenter discussed at some length the possibilities of service as a coordinating council.

Two parts of the report of Dr. Watkins which were formerly adopted were:

1. That the N. A. R. S. T. maintain its own identity regardless of movements to form a National Council of Teachers of Science;

2. That the N. A. R. S. T. cooperate with any other movements in the formation of a National Council of Teachers of Science.

Following a discussion it was regularly moved and seconded that a committee be appointed to cooperate with committees of other organizations of Science Teachers to consider the advisability of establishing a National Council of Science Teachers. The Executive Committee named the following as members of this committee on cooperation:

H. A. Carpenter, *Chairman*; J. A. Hollinger, Florence Billig, E. S. Obourn, and Elliot R. Downing.

As a part of the activities of the Committee on Enlarged Organization arrangements were made for a joint meeting with the American Educational Research Association. (This meeting was held Tuesday, Feb. 27, 1934.) It was regularly moved and seconded that the Executive Committee be advised to continue this cooperative relation with the American Educational Research Association.

The proposals for amendments of the Constitution and By-laws were next considered. These proposals having been made at the Minneapolis meeting were submitted to the members in writing.

(1) Proposed amendment to the articles on membership (Article 3). Section 1, to remain as in the original constitution. Section 2, to be changed to read as follows: "No officer or member of the Executive Committee shall hold office for more than two years." Section 3, as in the original. After brief discussion it was regularly moved and seconded that this proposed amendment be tabled. The motion was passed unanimously.

(2) Proposed amendment to Article 4 of the constitution. The statement in this article reads as follows:

Individuals who have contributed outstanding service of any nature may, upon recommendation of the Executive Committee and approval of members, be admitted to membership.

Proposed amendment:

(a) Applications for membership shall be proposed in writing by a member in good standing and indorsed by two other such members. The application shall become approved and accepted by two-thirds vote of the members present at the annual meeting.

(b) This amendment shall operate to waive all other membership restrictions that may be in effect at this date (Feb. 28, 1934). After brief discussion it was regularly moved and seconded that this proposal be tabled. The motion was passed with one dissenting vote.

A nominating committee was appointed by the president, consisting of Ira Davis, V. H. Noll, and H. A. Webb, *Chairman*.

It was regularly moved and seconded that a committee be appointed to consider and make recommendations on qualifications for membership.

It was regularly moved and seconded that a committee be appointed to make recommendations on tenure of office and membership in the Executive Committee.

The report of the Committee on Publication was submited by Clarence M. Pruitt, business manager of Science Education. It was regularly moved and seconded that the report be accepted.

It was then moved that the Secretary-Treasurer be instructed to pay to SCIENCE EDUCATION, for subscription, $2.00.

Meeting adjourned.

The second session of the 7th annual meeting was held at the Hotel Cleveland on Monday morning, Feb. 26. The program was carried out as indicated on the printed announcement.

(1) Report of committee appointed to attempt to determine the grade placement of materials from the natural sciences for courses in elementary science for the first six grades, W. G. Whitman, *Chairman*. A plan of study reported by the committee was presented. It was regularly moved and seconded that the report be accepted.

(2) Report of committee appointed to investigate the possibilities of measurement of scientific attitudes as products of instruction in the natural sciences, Francis D. Curtis, *Chairman*. This was presented as a progress report. It was regularly moved and seconded that the report be accepted.

(3) The report of the committee appointed to attempt to establish criteria for the selection of content for courses in natural sciences, A. W. Hurd, *Chairman*. Criteria which had been selected and evaluated by the committee were reported. It was regularly moved and seconded that the report be accepted and the committee discharged.

The report of the Secretary was presented and approved. Submitted Feb. 26, 1934.

Balance on hand, Feb. 27, 1933	$186.04
Dues, 49 members at $5.00	245.00
Interest on balance	6.23
Total	$437.27
Subscriptions to SCIENCE EDUCATION, 49 at $1.00	49.00
Balance on hand Feb. 26	$388.27

(Bills outstanding about $25.00.)
(Dues outstanding $25.00.)

The report of the Nominating Committee was as follows:

President, A. W. Hurd, Institute of School Experimentation, Teachers College, Columbia University, New York.
Vice-President, E. E. Wildman, Director of Science Instruction, Philadelphia, Pa.
Secretary-Treasurer, S. Ralph Powers, Teachers College, Columbia University, New York.
Executive Committee, Ralph K. Watkins, University of Missouri, Columbia, Missouri, and C. Louis Thiele, Supervisor of Exact Sciences, Detroit, Mich.

It was regularly moved and seconded that the report of the committee be accepted and that the Secretary be instructed to cast a unanimous ballot favoring election to office of those named in their report. The motion received a unanimous vote.

S. RALPH POWERS, *Secretary*.

NATIONAL COUNCIL OF SUPERVISORS OF ELEMENTARY SCIENCE

MINUTES OF THE FIFTEENTH ANNUAL MEETING—MARCH 24, 1934

The fifteenth annual meeting of the National Council of Supervisors of Elementary Science was held in the Ballroom of the Statler Hotel, Cleveland, Ohio, on February 24, 1934.

The meeting was called to order at 9:30 A. M. by the President, Dr. Florence G. Billig. The first speaker, Miss Anna Burgess, Principal of Doan School, Cleveland, described the curriculum school as a method of building a course of study in elementary science. Miss Bertha Parker then gave a detailed account of a unit on air pressure as developed in the Elementary School, the University of Chicago. Mr. W. W. McSpadden presented an account of how the elementary science course articulates with the continuous science program in the schools of Austin, Texas. Dr. Philip G. Johnson, the University of Nebraska, discussed the content and organization of science syllabi as judged by experienced teachers. The morning session closed with a discussion of a program for the extension of work in science education by Dr. S. R. Powers, Teachers College, Columbia University.

Luncheon was served in the Lattice room of the Statler Hotel to two hundred and fifteen members and guests of the Council. After luncheon the room was cleared of tables. Chairs were moved into the luncheon room to accommodate the visitors who could not attend he luncheon but wished to hear the program. Dr. M. Luckiesh, Director, Lighting Research Laboratory, Nela Park, Cleveland, gave a most delightful address, entitled "Is Science Being Taught?" Mr. Ellis C. Persing, Western Reserve University, Cleveland, then presented the past officers of the Council. Each past officer present gave a word of greeting. Telegrams or personal letters were read from those unable to be present.

At the afternoon session, Dr. Otis Caldwell, Director of the Institute of School Experimentation, Teachers College, Columbia University, the first speaker, discussed the importance of research in the development of science in the elementary school. Dr. S. Prentiss Baldwin, of the Baldwin Bird Research Laboratory of Hillcrest Farms, Gates Mills, Ohio, spoke on conservation of wild life. The closing paper was an illustrated lecture by Dr. William G. Vinal, Western Reserve University, Cleveland, on the importance of camp experience in the equipment of teachers of science in the elementary school.

The annual business meeting was then called to order. The minutes of the previous meeting were read and adopted. The following financial report was read by the Secretary-Treasurer and adopted after having been approved by the Auditing Committee:

Financial Report

Receipts

Balance on hand February 25, 1933	$46.47
Received in dues for 1933–34 (not including the $9.00 in last year's financial report)	103.00
Received in dues for 1934–35	18.00
Received in subscriptions for *Science Education*	67.50
Received in subscriptions for *School Science and Mathematics*	38.25
Total Receipts	$273.22

Expenditures

Paid out to *Science Education* for subscriptions	$67.50
Paid out to *School Science and Mathematics* for subscriptions	38.25
Postage	30.64
Printing, paper, etc.	47.30
Stenographic help	24.55
Signs made for the Cleveland meeting	6.90
Local bank charges for collections	1.08
Express charges	3.10
Telegrams	2.32
Guest luncheon ticket, menu cards, etc.	2.00
Total Expenditures	$223.64
Balance on hand March 1, 1934	$49.58

Mr. H. A. Carpenter made a motion that a committee be appointed to study the need for and desirability of forming a national organization of science teachers. The motion was carried. The President appointed for this committee: Dr. H. A. Webb, *Chairman,* Dr. Philip G. Johnson, and Miss Mary Melrose.

Dr. E. E. Wildman made a motion to have the Constitution Committee make provisions for a Committee on Public Relations. The motion was carried. Until the provision can be written into the constitution, the President appointed on this committee: Dr. E. E. Wildman, *Chairman,* Miss Elizabeth Downhour, and Mr. H. A. Cunningham.

Miss Lillian Hethershaw, Chairman of the Constitution Committee, made a progress report for her committee. Since the work has not been finished, Miss Esther Scott moved that the committee continue its work for another year. This motion was passed.

Miss Downhour moved that the Secretary be instructed to write an official letter of appreciation to Miss Melrose, Mr. Persing, and Dr. Vinal for their help in making arrangements and assuring the success of the fifteenth annual meeting. This motion was unanimously passed.

Miss Esther Scott gave a summary of her complete report as the Council delegate to the Crime Commission held in Washington during the summer of 1933.

The Nomination Committee presented the following names for officers for the coming year:

For *President,* W. G. Whitman, State Teachers College, Salem, Massachusetts.

For *Vice-President,* W. W. McSpadden, Austin Public Schools, Austin, Texas.

For *Secretary-Treasurer,* Helen Dolman, Michigan State Normal College, Ypsilanti, Michigan.

The council voted election of the above slate as officers for the coming year.

A motion for adjournment closed the meeting.

There was an average attendance at the meeting of about three hundred and fifty. Regular members were pleased to see a goodly number of high-school teachers of science present. A local chemical society merged a part of its regular meeting with the morning and luncheon sessions of the Council. Due to the efforts of Miss Melrose, cars were arranged on the following Monday to take out-of-town members and visitors to the various Cleveland schools.

W. W. McSpadden,
Secretary-Treasurer

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